

THE
DESCRIPTION and USE
OF BOTH THE
GLOBES, &c.

THE

DESCRIPTION and USE

OF BOTH THE

GLOBES

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T H E
DESCRIPTION and USE
OF BOTH THE
G L O B E S,
T H E
ARMILLARY SPHERE,
A N D
O R R E R Y,
EXEMPLIFIED

In a large Variety of PROBLEMS in
ASTRONOMY, GEOGRAPHY, DIALLING, &c.
Carefully selected from the late Messrs. MARTIN,
FERGUSON, and other Eminent Men, that have wrote on
those Subjects.

A L S O,

A NEW CONSTRUCTION of the HOUR CIRCLE on the GLOBES,
and SEMI-CIRCLE of ILLUMINATION or SOLAR HORIZON,
and other IMPROVEMENTS on the GLOBES and ORRERY.

TO WHICH IS ADDED,

A Short ACCOUNT of the SOLAR SYSTEM,

By G. W R I G H T.

The whole Illustrated by a Variety of COPPER PLATE FIGURES.

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THE
DESCRIPTION and USE
OF BOTH THE
GLOBE
AND
ARMILLARY SPHERE
FOR
TEACHERS
AND
PUPILS



ASTRONOMICAL
PHYSICAL
AND
NATURAL HISTORY

A NEW SYSTEM OF THE GLOBE
AND
ARMILLARY SPHERE
AND
OTHER INSTRUMENTS OF ASTRONOMY

A NEW ACCOUNT OF THE SOLAR SYSTEM

BY
G. W. RICHARDSON

The whole illustrated by a Planisphere and a Star Map

LONDON

Printed for the AUTHOR, at the ASSOCIATED PRESS,
and at the BRITISH MUSEUM, by J. H. COOPER,
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P R E F A C E.

I Have a great Satisfaction to find the *New Improved Globes*, I published in January 1782 very much approved of, but am informed by many Purchasers, that on *Account of the Improvements*, a Treatise on their Use became essentially necessary, in consequence of which, I have compiled the following Sheets, taken principally from the late Mr. B. MARTIN, his being the last and most approved Book of the Kind, but was wrote of course to describe the GLOBES then in Use, the Alterations and Abridgments, made on Account of the new Improvements, are no more than what is absolutely necessary; in doing which, I have been careful not to omit any Thing that I thought useful for PRACTICAL ASTRONOMY and GEOGRAPHY by the Use of the GLOBES, what

what little I have taken from other Authors
and added of my own, chiefly consists of a
DESCRIPTION of the ORRERY, PLANETA-
RIUM, &c. and a short Account of the SOLAR
SYSTEM, illustrated by Copper PLATES.

Leadenball-Street.

Nov. 30, 1783.

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DESCRIPTION

DESCRIPTION

And USE of the

GLOBES.

CHAP. I.

DEFINITIONS. and PRINCIPLES necessary to be premised to the
Use of the GLOBES. Of the FRAMES, EXTERIOR CIRCLES
and other APPARATUS.

Definition I.

AN artificial GLOBE is a round solid Body, having every Part of its Surface equally distant from a Point within it, called its *Centre*. This, indeed, is rather a *geometrical*, than a *geographical* Definition of a Globe; because our artificial Globes are rather *solid Surfaces* than *solid Spheres*, as they are for the greatest Part hollow withinside.

Def. II. A SPHERE is the same with a Globe, in a geometrical Sense of the Word, whether superficial or solid.

Of artificial Globes there are two Sorts, one called the *Cestial Globe*, and the other *Terrestrial*.

Def. III. The CELESTIAL GLOBE is that which has on its Surface a proper Representation of all the visible Stars in the Heavens, and the Images or Figures of the various CONSTELLATIONS into which those Stars are arranged, and which are called ASTERISMS.

Def. IV. The TERRESTRIAL GLOBE is an artificial Representation of all the Parts of LAND and WATER which constitute the Surface of the real Globe of the Earth in their proper Quantity, Form, Situation, and all other Circumstances.

To render these Globes useful, they are disposed in Frames, and are *moveable* round an Axis, so as to represent the diurnal Motion of the Earth and Heavens. They are also moveable in another Respect, so as to have any Part raised or depressed in a vertical Manner.

B

Def.

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Def. V. The *Axis* of a Globe, is that Right Line which passes through the Center, and about which it revolves.

Def. VI. The *POLES* of a Globe are the two extreme Parts of the *Axis* in the Surface of the Globe.

Def. VII. A *GREAT CIRCLE* of a Globe, or Sphere, is that which divides it into *two equal Parts*.

Def. VIII. A *small CIRCLE* is that which divides the Surface of a Globe, or Sphere, into *two unequal Parts*.

Def. IX. *PARALLELS*, or *secondary Circles*, are such small Circles on the Surface of the Globe, or Sphere, as are every where *equally distant* from their corresponding great *Circle*.

Def. X. A *DEGREE* is the 360th Part of a Circle, so that every Circle, *great* or *small*, is understood to be divided into 360 of those equal Parts, or Degrees; and each one of those Degrees is supposed to be subdivided into 60 equal Parts called *Minutes*, and each Minute is again divided into 60 equal Parts called *Seconds*, and so on to *Thirds*, *Fourths*, &c.

Def. XI. The *POLE* of any Circle in the Surface of a Globe, or Sphere, is a Point every way equally distant from it; consequently, the Pole of a *GREAT Circle* is every where at the Distance of *ninety Degrees*.

In order that the Globes may answer, in the best Manner, every Purpose they are designed for, 'tis necessary they should move within various Circles circumscribed without them, which may be called exterior, or *moveable Circles*; and also to have other Circles drawn on their Surfaces, as the Rules of Art require, which therefore may be considered, or distinguished as *fixed Circles*.--These Circles of the Globe, or Sphere, are to be conceived as corresponding to the same Circles supposed to be situated in similar Parts of the concave Surface of the Heavens, or upon and about the convex Surface of the Earth, which therefore are called the *imaginary Circles* of the Sphere: by Means of these Circles the various Parts of the Heavens and the Earth, together with their different Phænomena, may, by Means of the artificial Globe, be rendered very easy to be conceived and understood.

The exterior, or moveable Circles, are those which follows:

Def. XII. The *wooden HORIZON* is the upper Part of the Frame, and is that broad Circle, whose upper Side represents the Horizon of the Place, and consists of several useful Circles; one of which contains the twelve Signs of the *Zodiack*, distinguished by their Names and Characters; and each

each Sign is divided into 30 Degrees: next to this is a Circle, with the *Gregorian* Calendar disposed into Months and Days. Another Circle has all the *Points of the COMPASS*, or the WINDS, as they are denominated by Seamen. Besides the Circles of AMPLITUDE, and AZIMUTHS, &c.

Def. XIII. *Cardinal POINTS* are the four principal Points of the Horizon, which are called *South, East, North, and West*. From hence, that Pole of the Globe which is turned towards the North Point of the Horizon is called, the *North Pole*; and, of Course, that which is opposite to it, the *South Pole*.

Def. XIV. The ZENITH is the uppermost Pole of the Horizon, or it is the most elevated Point on the Surface of the Globe, in which the Eye of the Spectator is supposed to be placed: or in the Heavens, it is the point *vertically* over ones Head; this artificial Horizon corresponds with that great Circle which bounds our Sight in the Heavens, and in which all the heavenly Bodies are said to *rise* and *set* when they ascend above, or descend below it.

Def. XV. The NADIR is the lower Pole of the Horizon, and therefore is a Point in the Surface of the Globe diametrically opposite to the Zenith.

Def. XVI. The AMPLITUDE is the Distance in Degrees, reckoned from the East or West Point of the Horizon, towards the South or North, and is distinguished into the *Ortive* and *Occasive*, or the Amplitude at the *rising* and *setting* of any heavenly Body.

Def. XVII. ALMICANTHERS are small Circles, parallel to the Horizon, and are called *Parallels of Altitude*.

Def. XVIII. The *general* or *brazen* MERIDIAN, is that large Brass Circle in which the Globe is suspended by the Ends of the Axis produced, and is voluble about it: It has its Name from representing that Circle in the Heavens, or on the Surface of the Earth, where the Sun is at the Moment of Noon, or twelve o'Clock, (because Noon, in *Latin*, is called *Meridies*, or Mid-day.) This Circle is divided, on that Side facing the East Point of the Horizon, into four Quarters, containing ninety Degrees each, which Division begins on the middle Point between the Poles on the southern Half of the Meridian, and is numbered each Way towards either Pole; but in the other Half the Meridian, the Degrees are numbered from the Poles towards the middle Point. This Meridian is supported, and moveable on a Brass Base, fixed on the Pedestal, the Frame, is also in

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two Notches cut in the South and North Parts of the Horizon, by which Means the Poles of the Globe are elevated or depressed, alternately, to any Altitude, or Number of Degrees above the Horizon required, and there fastened at Pleasure, by means of a Milled Head Screw through the Brass Base, into a Groove on the back of the Brass Meridian.

Def. XIX. The *Quadrant* of ALTITUDE is a thin Slip of Brass, whose Edge is divided into ninety Degrees; and it is contrived to be moveable on the Brass Meridian, and to be fixed to any Part by a Nut and Screw: Of Course, when it is fixed to the Zenith, or Pole, of the Horizon, it will serve to measure the Altitude of any *Phænomenon* above the Horizon; because the Divisions begin at the Horizon, and are reckoned upwards on the Quadrant.

Def. XX. A *Vertical CIRCLE* is a great Circle of a Sphere, which passeth through the Poles of the Horizon, or turns upon the Zenith and Nadir Points; and that which passes through the East and West Points of the Horizon is called, the *prime Vertical*, or the Principal of them all. Hence it is easy to understand that the Quadrant of Altitude, fixed on the Zenith Point of the Meridian, will indifferently, and generally represent any of those *vertical Circles* in its Motion about the said Point, or Pole of the Horizon.

Def. XXI. The AZIMUTH is the Quantity of the Angle contained between a verticle Circle and the Meridian reckoned or measured in Degrees of a Circle on the Horizon, from the North or South Points to the East or West. The Quadrant of Altitude therefore, being laid over any particular Place on the Surface of either Globe, will shew its Azimuth on the Horizon.

Def. XXII. The HOUR-CIRCLE in common mounted Globes, is a small Circle fixed on the Brass Meridian, with the Pole of the Globe in its Center: It is divided into twice twelve Hours: The *twelfth Hour* at Noon, is upon the upper Part of it, at the Meridian; and the XII at NIGHT is on the Meridian, at the lower Part towards the Horizon. The Axis of the Globe, projecting above the Brass Meridian, carries round the *Index* or HAND, which shews the Hour and is easily moveable, on the said Axis, to any Hour proposed, when the Globe is held at Rest.

Def. XXIII. The MARINERS COMPASS is a Box containing a magnetical Needle, freely moving on a fine Point,
in

For the USE of the GLOBES.

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in the Center of a Circle divided into four times ninety Degrees, reckoning from the North and South towards East and West; and also into the thirty-two Points of the Compass, properly marked: As this Needle has the Property of making a certain constant Angle with the Meridian in every Place, which Angle is called the *Variation*, therefore this Compass, being added to the Frame, will shew the Position of the Meridian when the Variation of the Needle is known. Thus, at *London*, the Variation is at this time about 21 Degrees Westward; therefore, by moving the Frame of the Globe one Way, or the other, 'till the Needle settles itself over the twenty-first Degree, reckoned Westward from the North Point, or *Flower-de-Luce*, we shall have the Brass Meridian coinciding with the true Meridian of *London*.

C H A P. II.

*Of the CIRCLES delineated on the SURFACES of the GLOBES,
and their various Uses.*

*On the Surfaces of the Globe are delineated the following
Circles.*

Definition XXIV.

THE EQUINOCTIAL on the Celestial or the EQUATOR on the Terrestrial Globe, is that great Circle whose Plane divides the Globe into two equal Parts, viz. the Northern and Southern Hemispheres, whose Poles are the Poles of the Globe itself. It is divided into 360 Degrees, reckoned Eastward quite round to the Point where they begin.

Def. XXV. RIGHT ASCENSION, in MOTION is that Degree, or Point of the Equinoctial Line, (reckoned from the first Point of Υ) which is upon the Meridian, with any Phænomenon in the Heavens upon the celestial Globe; and is so called, because it rises with the Luminary in a *Right Sphere*.

Def. XXVI. RIGHT ASCENSION in Time, is the right Ascension in Motion converted into Time by allowing 15°
to

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to an Hour; for as the Globe revolves on its Axis in XXIV Hours, there must, in each Hour, pass under the Meridian 15° of the Equinoctial Line; and, consequently, every Degree will Answer to four Minutes of Time; and $15'$ of a Degree to one Minute of Time; $15''$ of a Minute of a Degree to one Second of a Minute in Time, and so on: so that the Time in which any Motion in the Equinoctial, or Equator, is performed, will be easily known by a Table hereafter inserted.

Def. XXVII. OBLIQUE ASCENSION is that Point of the Equinoctial which rises with a Star, or other Phænomenon, in an oblique Sphere.

Def. XXVIII. LONGITUDE, on the Terrestrial Globe, is that Degree of the Equator which comes to the Meridian with any given Place; or it is the Distance East or West of the Meridian of London on the New Globes; so, that Longitude on the Terrestrial Globe is the same as right Ascension in the Celestial, and is in the same Manner to be converted into Time.

Def. XXIX. The DECLINATION is the Number of Degrees, reckoned in the Meridian, at which any Star is placed from the Equinoctial Line towards the North or South Pole.

Def. XXX. The LATITUDE of a Place, on the Terrestrial Globe, is, in like Manner, the Distance of a Place from the Equator, measured in Degrees of the Meridian, towards the North or South Pole.

Def. XXXI. PARALLELS of *Declination* and *Latitude*, are those lesser Circles which are drawn on the Surface of the Globes, *parallel* to the Equinoctial, or Equator: they are usually drawn through every tenth Degree of Latitude, or Declination.

Def. XXXII. The ECLIPTIC is a great Circle, divided into twelve equal Parts called SIGNS, and each Sign contains thirty Degrees. These take their Names from those Constellations in the Heavens, through or near which they passed at the Time those Names were given to them. This Circle makes an Angle with the Equinoctial of about $23^{\circ} 28'$, which is called, the *Obliquity* of the Ecliptic. This Circle represents the annual Path of the Sun through the Heavens among the fixed Stars; and because the *Eclipses* must necessarily happen in this Line, where the Sun always
is,

is, it is therefore, called the *Ecliptic*. The Names, Characters, and Order of the Signs of the Ecliptic are as follow:

1. ♈ *Aries*, or the Ram.
2. ♉ *Taurus*, the Bull.
3. ♊ *Gemini*; the Twins.
4. ♋ *Cancer*, the Crab.
5. ♌ *Leo*, the Lion.
6. ♍ *Virgo*, the Virgin.
7. ♎ *Libra*, the Balance.
8. ♏ *Scorpio*, the Scorpion.
9. ♐ *Sagittarius*, the Archer.
10. ♑ *Capricornus*, the Goat.
11. ♒ *Aquarius*, the Water-Bearer.
12. ♓ *Pisces*, the Fishes.

The first six are called the *northern* Signs, as they lie on the Northern Hemisphere; and the latter are the *Southern* Signs. By this division of the ecliptic Line, we can more readily point out the Sun's Place in the Heavens, for any given Time, by saying, *it is in such a Degree of such a Sign*.

Def. XXXIII. The EQUINOCTIAL POINTS are those in which the Ecliptic and Equinoctical intersect each other; of which that is called, the *Vernal Equinox* when the Sun is in the Equinoctial Line in the *Spring*: and the other is called the *Autumnal Equinox*, as the Sun, at that Season of the Year, crosses the Equinoctial Line again. The beginning of the Ecliptic, as well as of the Equinoctial Line, is at the Vernal Equinox; and, accordingly, the right Ascension is reckoned from the first Point of Aries.

Def. XXXIV. The LONGITUDE of a Star, or Planet, is its Distance from the first Point of *Aries* in the Ecliptic, reckoned in Signs, Degrees, Minutes, &c.

Def. XXXV. The LATITUDE of a Star, or Planet, is its nearest Distance from the Ecliptic, towards the Poles of the Ecliptic, on either Side, North or South: As the Ecliptic makes an Angle of $23^{\circ} 28'$. with the Equinoctial, so the Poles of the Ecliptic will of Course be at the same Distance from the Poles of the World.

Def. XXXVI. CIRCLES of LATITUDE are those great Circles which pass through the Poles of the Ecliptic, and consequently intersect the Ecliptic at right Angles. These are peculiar to the Celestial Globe, and are usually drawn through every 30° , dividing the whole Surface of the Globe into

into twelve equal Parts: By some Authors, these are also called *Circles of Longitude*, because, being drawn through any Star, they reduce it to, and shew its *Longitude* in the *Ecliptic*.

Def. XXXVII. The ZODIAC is a broad Space on the Surface of the Celestial Globe, extending to about 8° on each Side of the *Ecliptic*, in which are contained, the twelve *Asterisms*, or Constellations which give Names to the Signs; and because most of these have the Likeness of some living Creature, this Space received the Name of *Zodiac*, which signifies a *Zone of Animals*. In this broad Circle are included, the Orbits of the Moon and all the Planets; and, as it is of the greatest Use in practical Astronomy, it is put on the New Globes, and divided into each single Degree of Latitude on either Side the *Ecliptic*.

Def. XXXVIII. The TROPICS are those Parallels of *Declination*, on the Celestial Globe, (of *Latitude* in the Terrestrial) which touch the *Ecliptic* on either Side; and, because one in the Northern Hemisphere touches the *Ecliptic* in the Beginning of *Cancer* it is called the *Tropic of Cancer*: for the same Reason, that which touches the *Ecliptic* in the Southern Hemisphere is called the *Tropic of Capricorn*. The Word *Tropic* denotes a *Return*, because, in those Points, the Sun returns again to the Equinoctial Line.

Def. XXXIX. The POLAR CIRCLES are those Parallels of Declination (or Latitude in the Terrestrial Globe) which circumscribe the Poles of the World at the Distance of $23\frac{1}{2}^\circ$ Degrees; or they are the Parallels of $66\frac{1}{2}^\circ$ Degrees. That on the Celestial Globe, about the North Pole, passes through the Constellation called *Arctos*, or the *Bear*; from whence it is usually called the *Arctic Circle*: and that which is opposite to it, about the South Pole, is called the *Antarctic Circle*. Both these and the Tropics are delineated on the Globes by dotted Lines, to distinguish them from other Parallels.

Def. XL. The MERIDIANS are those great Circles, on the Terrestrial Globe, which pass through, or intersect each other in the Poles of the World, and, of Course, are at right Angles to the Equator, where they determine the Longitude of Places through which they are drawn: one of these Meridians is called the FIRST MERIDIAN, from which the Reckoning in the Equator begins. The Position of this Meridian is arbitrary: But, on the New Globes, the first Meridian

Meridian passes through the City of LONDON, as being the Capital of our own Country, these Meridians are drawn through every fifteenth Degree.

Def. XLI. HOUR CIRCLES are those Meridians which pass through every fifteenth Degree of the Equinoctial, on the Celestial Globe, dividing the Surface of the Globe into 24 equal Parts, each of which, therefore, passeth under the Brazen Meridian in the Space of one Hour, as we have hinted before, and seen by Inspection by the new Hour Circle, which will be fully described hereafter.

Def. XLII. The SOLSTICES are those Points of the Ecliptic which have the greatest Declination, and consequently the Beginning of *Cancer* and *Capricorn*: They are so called from the Sun appearing, as it were, *stationary* in those Points, with respect to its Motion Northward and Southward; for its Declination alters but very little, or is scarcely sensible for many Days on one Side or the other of these Points, which are therefore called the *Solstitial Points* of the Ecliptic.

Def. XLIII. The COLURES are two Meridians which pass through the Equinoctial and Solstitial Points, and consequently cross each other at right Angles in the Poles of the World: Hence one of them is called the *Equinoctial Colure*, and the other the *Solstitial Colure*. These Circles divide the Surface of the Globe into four equal Parts, denoting the four SEASONS of the Year.

Def. XLIV. The RECESSION of the EQUINOXES is that slow Motion which the Equinoctial Points are, by long Observation, found to have from East to West, contrary to the Order of the Signs, at the Rate of one Degree in 72 Years, and by this retrograde Motion of the Equinoctial Points, and consequently of the Ecliptic, the Signs have departed from the Constellations in which they originally were, which has caused all those Constellations to have an apparent Motion forward: and thus we find the Constellation of *Aries* is now (not in the Sign of that Name, but is) advanced forward into the second Sign, taking the Place which *Taurus* formerly had. *Taurus* being now in *Gemini*, and so on; which is the Reason why you see the Constellations drawn as they are on the Celestial Globe. The physical Cause of all which is, our Earth, not being of a truly spherical Figure, but a little flatted at the Poles, must have a *conical Motion* of its Axis, which carries the Poles of the

World round the Poles of the Ecliptic in the long Period of nearly 26000 Years, which has been called the great *Platonic Year*.*

Def. XLV. An *Armillary SPHERE* is an astronomical Instrument, consisting of an artificial Disposition of all the great and small Circles of Note, before described, *viz.* the *Horizon*, the *Brass Meridian*, the *Equinoctial*, the *Ecliptic* with the *Zodiac*, the *Equinoctial*, and *Solstitial Colures*, the *Tropics* and *Polar Circles*, the *Axis* of the *World*, with the small *Hour Circle* and *Index*; all which compages of Circles revolve like the *Globe*, on the *Axis* of the *World*, and thereby greatly facilitate the Idea we ought to have of those imaginary Circles in the *Heavens*, and their several *Uses*; And, by Means of the *Quadrant* of *Altitude*, any spherical *Triangle* may be formed, and its *Solution* given by *Inspection*; which renders this Instrument of great *Utility* in *Astronomy*, and the *Use* of the *Globes*; a *Print* of which we have therefore thought necessary to prefix to these *Definitions*.

With respect to the *Position* of the *Sphere* or *Globe*, there are the following *Distinctions*:

Def. XLVI. A *Parallel SPHERE* is that *Position* of it where the *Equator* coincides with the *Horizon*, and consequently the *Poles* of the *World* are the *Zenith* and *Nadir* *Points*. The *Parallels* of *Latitude* here are all parallel to the *Horizon*; but there can be no such *Disposition* of the *Sphere*, but to an *Inhabitant* immediately under the *Poles*. See *Fig. 4. Plate 2d.*

Def. XLVII. A *right, or direct SPHERE* is that *Position* where the *Equator* and all its *Parallels* make *right Angles* with the *Horizon*. The *Inhabitants* of this *Sphere* are only those who live under the *Equinoctial Line*. See *Fig. 5.*

Def. XLVIII. An *Oblique SPHERE* is when the *Equinoctial* makes an *oblique Angle* with the *Horizon*: and therefore is any other *Position* than the two former, and which every *Inhabitant* must have who does not live under the *Equator* and the *Poles*.

Def. XLIX. † The *Diurnal ARCH* is that Part of a Pa-
Def.

* So called from *PLATO* the Disciple of *SOCRATES*, who is said to have first observed this *apparent Motion of the Stars*; he died in the first Year of the 108th *Olympiad* on his *Birth-day*, in the 81st Year of his Age.

† Those *Arches* are shewn by *Inspection* at one *View*, by Means of the *New Solar Horizon*.

parallel of Declination which stands above the Horizon; the other Part, which is below it, is called the *Nocturnal Arch*.

Def. L. Ascensional DIFFERENCE is the Difference in the *Ascension* of an Object above the Horizon, in a right and an oblique *Sphere*; but in a right *Sphere*, every Celestial Phenomenon must rise and set at the Distance of *six Hours*, from the Time of its being on the Meridian; therefore the ascensional Difference, turned into Time, shews how long the Star rises or sets before, or after the Hour of *six*, in an oblique *Sphere*.

C H A P. III.

Geographical and Astronomical DEFINITIONS and PRINCIPLES relative to the USE of the GLOBES, continued.

THE Surface of the *Terrestrial* or *Terraqueous Globe*, consists of LAND and WATER, very nearly in Proportion as *one to three*;

The LAND is divided as follows:

I. A CONTINENT is the largest Division, or extent of Land, comprehending diverse Countries and Kingdoms not separated by Water.

II. An ISLAND is any small Tract of Land surrounded by Water.

III. A PENINSULA, is a Part of Land encompassed with Water all round, except on one Part, which is called

IV. An ISTHMUS, being that narrow Neck of Land which joins it to the Continent.

V. A PROMONTORY is a mountainous Part of Land, standing far out in the Sea, whose Fore-part is called

VI. A CAPE, or *Head-Land*.

The aqueous Part of the Surface of the Earth has the following Distinctions, or Divisions:

I. The OCEAN is the largest Collection of Waters which lie between, and environs the Continents.

II. The SEA is a smaller Part of the aqueous Surface of the Earth, lying between the Islands, Promontories, &c.

III. A GULPH is a Part of the Sea every where environed with Land, except on one small Part, called

IV. A STREIGHT, or STRAIT, which is that narrow Passage joining it to the adjacent Sea.

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V. A LAKE is any large Quantity of stagnant Water, entirely surrounded by Land.

These several Denominations of Land and Water need no farther Account or Description, as a bare Inspection of the Globe will present them sufficiently to the View.

The most famous Division of the Surface of the Earth, with regard to Heat and Cold, is into the five ZONES, of which, one is called the *Torrid Zone*, two are called *Temperate Zones*, and the other two *Frigid Zones*. See Fig. 7:

I. The *Torrid ZONE* is so called, from the Inhabitants being, as it were, *torrified* or scorched with the Sun's Heat; for this Part of the Earth is all that which lies between the two Tropics of *Cancer* and *Capricorn*, and over which the Ecliptic Line is obliquely posited: from whence you will easily observe, that the Inhabitants of this Zone will have the Sun *vertical* two Days in the Year, in passing from Tropic to Tropic, in each Half of the Ecliptic.

II. The *Temperate ZONES* are all those Parts of the terraqueous Globe which lie between the TROPICS and *Polar CIRCLES*; and consequently there is one of these in the Northern, and one in the Southern Hemisphere, as you may see very plainly on the Surface of the Globe. As we ourselves are Inhabitants of the North Temperate Zone, we find the Seasons of the Year in a *temperate* Degree: Our *Summer* Suns are at a Distance from our *Zenith*, and we do not therefore experience the greatest Force of his Beams. Again, we are never without his enlivening Influence the Space of one natural Day; so that, upon the whole, we must reckon our situation the best that the Surface of the Earth can afford; the paradisaical Situation of *England* being the *most Temperate Part of the Temperate Zone*.

III. The two *Frigid ZONES* are so called because of the *excessive Cold* in those Parts: These are improperly called *Zones*, being rather *Areas* comprehended between the *Arctic* and *Antarctic* Circles; but, as with a little Consideration it will appear, that since one Half of the Year the Sun is above the Horizon, to the greatest Part of these *Zones* for many Days and Months together, without setting, they must have a very considerable Interval of *warm*, or rather *hot season*; and, since the *Pole* itself is enlightened constantly for six Months together, it must be considered as the *hottest* at one Time, as well as the *coldest Part* at another, of the whole Earth.

There is another Division of the Earth's Surface into what they

they call CLIMATES; but this was more in Use among ancient Geographers, than the Modern: They called all that Part of the Earth, a *Climate*, which allowed an Increase of Half an Hour to a natural Day of 24; or the *first Climate*, extending from the Equator to that Parallel where the Day was $12\frac{1}{2}$ Hours long; from thence to the Parallel where the Day was 13 Hours, was called the *second Climate*, and so on, through a Succession of 24 *Climates*, till they came to the *Polar Circles*, where, the Sun not setting, the Day is 24 Hours long. Here they reckoned their *Climates* by monthly Illuminations, and so had *six Climates* within each *Frigid Zone*. But, to give a clearer Idea of this Matter, we shall give the following Table of *Climates*.

A TABLE of the CLIMATES.

CLIMATES between the Equator and the Polar Circles.											
Cli- mates.	Longest Day.	Latitude.		Breadth.		Cli- mates.	Longest Day.	Latitude.		Breadth.	
		D.	M.	D.	M.			D.	M.	M.	D.
1	$12\frac{1}{2}$	8	25	8	25	13	$18\frac{1}{2}$	59	58	1	29
2	13	16	25	8	00	14	19	61	18	1	20
3	$13\frac{1}{2}$	23	50	7	25	15	$19\frac{1}{2}$	62	25	1	7
4	14	30	25	6	30	16	20	63	22	0	57
5	$14\frac{1}{2}$	36	28	6	8	17	$20\frac{1}{2}$	64	6	0	44
6	15	41	22	4	54	18	21	64	49	0	43
7	$15\frac{1}{2}$	45	29	4	7	19	$21\frac{1}{2}$	65	21	0	32
8	16	49	1	3	32	20	22	65	47	0	26
9	$16\frac{1}{2}$	51	58	2	57	21	$22\frac{1}{2}$	66	6	0	19
10	17	54	27	2	29	22	23	66	20	0	14
11	$17\frac{1}{2}$	56	37	2	10	23	$23\frac{1}{2}$	66	28	0	8
12	18	58	29	1	52	24	24	66	31	0	3
CLIMATES between the Polar Circles and the Poles.											
Length of Days.			Latitude.		Length of Days.			Latitude.			
Months.			D.	M.	Months.			D.	M.		
1			67	21	4			78	30		
2			69	48	5			84	5		
3			73	37	6			00	00		

There are some other Distinctions in Geography, concerning the INHABITANTS of the Earth, in regard to their different Meridians or Parallels, viz. some are called the

PERIOECI, that live under the *same Parallel*, but, in the *opposite Semi-Circles of the same Meridian*; both of them have the Seasons of the Year the same; the Sun, by its annual apparent Motions, coming to, or receding from the Vertex of both Places at the same Time of the Year: but they change

change their Turns of *Night* and *Day*, so that when it is *Mid-day* to one, it is *Mid-night* to the other.

ANTOECI, are such whose Habitations lie in the *same Semi-circle* of the Meridian, but in *opposite Parallels*, and both of them have *Mid-day* and *Mid-night* at the same Instant of Time: but the Seasons of the Year are different, it being *Summer* to the one when it is *Winter* to the other.

Lastly, the ANTIPODES, are those whose Habitations being situated in *opposite Parallels*, and *opposite Meridians*, have their Feet *directly opposite to each other*, in a Line passing through the Center of the Earth: and they have not only their *Days* and *Nights* *directly contrary*, but also the *Seasons of the Year*; when it is *Summer* in the one, it is *Winter* in the other Place, and when *Mid-day* in the first, the second has *Mid-night*.

The Inhabitants likewise receive another Denomination from their *Shadows*, viz. the Inhabitants of the Torrid Zone, are called

The AMPHISCII, having their Meridian Shadows at Different Times of the Year, projected towards *both Poles*; but when the Sun comes to be vertical to them, then they have no Shadow, and are called *Ascii*, or *shadowless*, nothing that stands upright, having a Shadow at Noon.

The HETEROSCHII are those who inhabit the Temperate Zone, as having the Meridian Shadow projected *only towards one Pole* throughout the whole Year.

The PERISCHII are those who inhabit the two Frigid Zones, so called, because their Shadow turns *quite round* them in the Space of 24 Hours.

To these Definitions we may add, the Distinctions which the ancient Poets made, and are still retained in the Writings of Astronomy, relative to the rising and setting of the Stars, which they call the *Cosmical*, *Acronical* and *Heliacal*.

The *Cosmical* RISING or SETTING of a Star, is when it rises or sets at the Time when the *Sun rises*.

The *Acronical* RISING of the Star, is when it rises when the *Sun sets*.

The *Heliacal* RISING, is when the Star, or Planet *emerges out of the Sun beams*, and is seen in a Morning before Sun rising; and it *sets Heliacally* when it is so near the *Sun-beams* that it ceases to be seen.

Some other Definitions result from the Consideration of the Motion of the Earth; that the Earth hath a Motion
about

about its Axis is well known, and because we call the Time in which it makes one Revolution a DAY, therefore this is called the *diurnal Motion* of the Earth.

It is also well known, that the Direction of this Motion is from West to East, or according to the Order of the Signs of the Ecliptic in which they *follow* one another; and therefore this, and all such Motions are said to be in *Consequentia*.

This real Motion of the Earth, from West to East, occasions an apparent Motion of all the heavenly Bodies in a contrary Direction, or from East to West, which is therefore said to be in *Antecedentia*.

The Space of Time in which the Earth revolves upon its Axis is twenty-three Hours, fifty-six Minutes, three Seconds, and twenty-eight Thirds; in which Space of Time a fixed Star will make one complete Revolution: This Space of Time is therefore called the *Sidereal-Day*.

But the Time in which the Sun departs from the Meridian and returns to it again, or makes one Revolution, is called the *Solar-Day*. After the same Manner, we may consider that the Space of Time in which those Meridian-Revolutions are performed by the Moon and Planets, may, in like Manner, be called *Lunar* and *Planetary Days*.

ASTRONOMERS begin the Day at Noon, and call the natural Day, including Common Day and Night, the *Nyct-hemeron*; and they Number the Hours from one to twenty-four Hours successively, and not by twice twelve, as the common Usage is by Clocks.

The YEAR, with Astronomers, begins when the Sun enters the first Scruple of *Aries*, on the first Sign of the Ecliptic: but this Beginning of the Year cannot, on that Account, be stable, or fixed; because, as we have before observed, the Equinoctial Points have a slow Motion in *Antecedentia*, or contrary to the Order of the Signs: Therefore the Sun, which moves in a contrary Direction, or in *Consequentia*, will arrive at the vernal Equinox sooner, each Year, than it would have done, had that Point been fixed: consequently, the Moment of Time in which the Sun enters the *vernal Equinox* will happen a little Matter sooner, every Year, than it did in the preceding Year, *viz.* by about *twenty Minutes*. The Time of this vernal Equinox will, therefore, constantly anticipate the Time of the preceding One, and this is what is so frequently called the *Precession* of the *Equinox*.

The

The PLACES in which the heavenly Bodies appear, as viewed from the Earth or Sun, are differently denominated: The Place of a Planet when viewed from the EARTH, is called the *Geocentric* Place; but when it is viewed from the SUN, it is called the *Heliocentric* Place. Accordingly, in the *Ephemeris*, (which ought ever to be had at Hand when the Globes are in Use) these Places are properly tabulated, the *Geocentric* Places of the Sun, Moon, and Planets, for every Day of the Month through the Year; and the *Heliocentric* Places for every *sixth* Day only.

These *Geocentric* Places we have regard to in the Use of the GLOBES, and the *Heliocentric* ones become necessary in the Use of the ORRERY. The difference between the *Geocentric*, and the *Heliocentric* Place of a Planet, is equal to the Quantity of the Angle under which the Radius of the Earth's Orbit is seen from the Planet which is therefore called the *Parallax* of the *annual* ORBIT. The Word *Parallax* meaning no more than the *Difference of Places* in which the same Object will appear if viewed from two different Stations.

The NODES of a Planet's Orbit are those Points in which the Orbit intersects the Ecliptic. Thus the Equinoctial Points may be called the Nodes of the Sun's Orbit, with respect to the Equinoctial Line; but the Nodes of the Planets are of little Account, as they are too slow to have a sensible Motion in the Space of a few Years; and the Obliquity of their Orbits, or their Inclinations to the Plane of the Ecliptic, are for the most Part too small to be regarded in the Use of the Globes: But it is far otherwise with respect to the NODES and ORBIT of the MOON; the latter of which makes an Angle of no less than $5^{\circ} 18'$ with the Ecliptic, and the *Lunar Nodes* have too sensible a Motion not to be regarded even in the Use of the Globes, and therefore a Table is provided in the *Ephemeris* to ascertain the Place of the ascending Node for every sixth Day of the Month throughout the Year. This gives Occasion for the Nodes and Orbit of the Moon to be continually *rectified* on the Surface of the Celestial Globe.

As we see not the *true* and *real* MOTION of the Planets from the EARTH, but only their *apparent* ones, the Direction of those Motions will be often apparently variable; for sometimes they will appear to be *direct* in Motion, sometimes *retrograde*, or to move from *East* to *West*; and between these

two contrary Directions, they will appear to have no Motion for some Time, or to be *stationary* in the Heavens; Therefore, in the *Ephemeris*, among the Geocentric Places of the Planets, you will see the Letter D at the Place where the Planet begins to appear *direct* in Motion; and against the Place where it begins to appear *retrograde* there is the Character R.

All that we have hitherto said concerning the Places, Nodes, &c. of the Planets, is found in the *Ephemeris* published annually.

The Figure of the Earth being nearly Globular, a Person who walks directly North or South, as his Eye is always to the Pole of the Horizon, that horizontal Circle in the Heavens must ever move through the same Space, or describe the same Arch on the Meridian in the Heavens, as he describes or goes through on the Meridian of the Earth: that is, if he walks through one Degree of the Terrestrial Meridian Northward, then will his Horizon descend one Degree on the Northern Part of the Meridian in the Heavens, and ascend one Degree on the Southern Part, and so for any other Space or Number of Degrees. Therefore if an Inhabitant of the Equator, who views the Poles of the World in the Horizon itself, were to set out on a Journey directly Northward, when he had travelled over *one Degree* he would observe the North Pole of the World to be elevated just *one Degree* above his Horizon; when he had proceeded over the Space of *ten Degrees*, as his Horizon was depressed so many Degrees below the Pole, so the Pole must of Course appear *elevated ten Degrees* above the Horizon, and so much will the South Pole be depressed: From whence it appears, that the Elevation of the Pole above the Horizon of any Inhabitant is always equal to his Distance from the Equator, in Degrees of the Terrestrial Meridian: And therefore it is evident, that *the Elevation of the Pole is always equal to the Latitude of the Place*: and this is a fundamental Theorem for the Rectification of both the Globes.

It has been found, by frequent Mensurations, that, in order to raise or depress the Pole one Degree, a Person must pass over the Space of $69\frac{1}{2}$ MILES directly North, or South, which, therefore, is the *English* Measure of one Degree of a Terrestrial Meridian.

Having now premised every Thing that seems to be necessary for the due Understanding the Use of the Globes, we
D proceed

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proceed to the Solution of such Problems in Astronomy, Geography, &c. as will afford a rational and instructive Amusement to the young Student in those Sciences, and to Ladies and Gentlemen in general.

CHAP. IV.

The Use of the CELESTIAL GLOBE *in the* SOLUTION of PROBLEMS *relative to the* SUN.

Problem I.

TO RECTIFY the Globe for any particular Place, as LONDON.

To rectify the Globe implies several particular Things to be done, as (1) Elevate the North Pole above the Horizon so many Degrees as is equal to the *Latitude of the Place*, (2) Find the *Sun's Place* in the Ecliptic on the Surface of the Globe, and bring it to the brazen Meridian. (3) The Sun's Place being under the Meridian, set the *Index* of the *Hour Circle* to XII. (4) Set the Meridian of the Globe North and South by the *Compass*, or *Magnetical Needle*, as directed in the Definition thereof. These Things being done, the Globe is *rectified*, or put into a Position similar to the concave Surface of the Heavens for the Latitude of London.

Prob. II. *To find the SUN'S PLACE in the Ecliptic for any given Day.*

For this Purpose, there are, on the broad Frame of the Horizon, a Calendar of Months and Days, placed by the Ecliptic, divided into its twelve Signs and Degrees, the 21st of *March* nearly answers to the Beginning of the Ecliptic, or first Point of *Aries*; In the Calendar, therefore, find the given day of the Month, and, against it, observe the corresponding Part of the Ecliptic, and that is the Sun's *mean Place* for that Day. Thus, for Example, against *May 11th* you find the 21st Degree of *Taurus* for the Place of the Sun in the Ecliptic at that Time.

Prob. III. *To find the Sun's DECLINATION for any given Day in the Year.*

Find

Find the Sun's Place in the Ecliptic, and bring it to the Meridian; and the Degree of the Meridian immediately over it, is the *Declination* sought. For Example; on *May* 11th the Sun's Place is in the 21st Degree of *Taurus*; this, being brought to the Meridian, will shew the Sun's Declination immediately over it to be 18 Degrees.

Prob. IV. *To find the SUN'S RIGHT ASCENSION.*

Bring the Sun's Place to the Meridian, and see what Point of the Equinoctial is intersected by the Meridian; which, for the 11th of *May*, will be found to be the $47^{\circ} 40'$ for the *Right Ascension* required for that Day.

Prob. V. *To find the SUN'S AMPLITUDE.*

Bring the Sun's Place to the eastern Part of the Horizon, and the Arch of the Horizon betwixt it and the eastern Point is the Amplitude *Ortive*, North or South: Then turn the Globe about till the Sun's Place is in the western Horizon, then will its *occasive* Amplitude be equal to the *Ortive*, and of the same Denomination. Thus, on the 11th of *May*, the Sun will rise with 30° of North Amplitude, and set as far from the western Point of the Horizon to the North.

Prob. VI. *To find the TIME when the SUN RISES, or SETS, on any given Day.*

Rectify the Globe for the given Day; then turn the Globe till the Sun's Place touches the eastern Part of the Horizon, and the Index of the Horary Circle will shew the Time of its rising. After that turn the Globe about till the Sun's Place comes into the western Semi-circle of the Horizon, and the Index will shew the Time of its setting for the given Day. Thus, on the 11th of *May* the Sun will be seen to rise about a Quarter after VI. and set the same Time before VIII.

Prob. VII. *To find the LENGTH of any given DAY or NIGHT.*

This is immediately deduced from the foregoing Problem; for since the Time between *rising* to the Meridian, and descending from thence to the Horizon, must be equal, therefore twice the Hour of setting will be the Length of the Day. Thus, on *May* 11, the Sun sets at VII^h 45', the double of which Number is XV^h 30', the Length of the Day; the Length of the Night must then be of Course VIII^h 30'. Thus the Length of the longest and shortest Days must be found on the Globe, as also the greatest Amplitudes,

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Declinations, &c. and, by a bare Inspection of the Globe, it will appear, that the *longest Summer Day* is equal to the *longest Night* in *Winter*, and, *Vice Versa*, in regard to the Nights.

Prob. VIII. To find the SUN's *oblique ASCENSION*.

Find the Place of the Sun in the Ecliptic, and bring it to the eastern Horizon: then observe the Degree of the Equinoctial in its Intersection with the Horizon, which for the 11th of May you will find to be $21^{\circ} 40'$, the *Oblique Ascension* required.

Prob. IX. To find the *Ascensional DIFFERENCE*, or the Time the SUN rises before or after SIX.

From the right Ascension (found by Prob. IV.) subtract the oblique Ascension, found by the last, and the Remainder is the *Ascensional Difference* in Degrees.

Thus for the	} The Right Ascension is	0	1
11th of May.		47	40
	} Oblique Ascension	21	40

Ascensional Difference 26 00

Prob. X. To Convert the DEGREES, Minutes, and Seconds, of right ASCENSION in the EQUINOCTIAL, into HOURS, Seconds, and Minutes of TIME.

This Problem, very useful in Astronomy, is most readily solved by the following Table;

TABLE

A T A B L E.

By which the Longitude exprest in Degrees, Minutes, and Seconds, &c. may be reduced to Hours, Minutes, and Seconds.

Deg.	H. M.	Deg.	H. M.	Degrees.	Hours.
Min.	M. S.	Min.	M. S.		
Sec.	S. T.	Sec.	S. T.		
1	0 4	31	2 4	70	4 40
2	0 8	32	2 8	80	5 20
3	0 12	33	2 12	90	6 0
4	0 16	34	2 16	100	6 40
5	0 20	35	2 20	110	7 20
6	0 24	36	2 24	120	8 0
7	0 28	37	2 28	130	8 40
8	0 32	38	2 32	140	9 20
9	0 36	39	2 36	150	10 0
10	0 40	40	2 40	160	10 40
11	0 44	41	2 44	170	11 20
12	0 48	42	2 48	180	12 0
13	0 52	43	2 52	190	12 40
14	0 56	44	2 56	200	13 20
15	1 0	45	3 0	210	14 0
16	1 4	46	3 4	220	14 40
17	1 8	47	3 8	230	15 20
18	1 12	48	3 12	240	16 0
19	1 16	49	3 16	250	16 40
20	1 20	50	3 20	260	17 20
21	1 24	51	3 24	270	18 0
22	1 28	52	3 28	280	18 40
23	1 32	53	3 32	290	19 20
24	1 36	54	3 36	300	20 0
25	1 40	55	3 40	310	20 40
26	1 44	56	3 44	320	21 20
27	1 48	57	3 48	330	22 0
28	1 52	58	3 52	340	22 40
29	1 56	59	3 56	350	23 20
30	2 0	60	4 0	360	24 0

EXAMPLE

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EXAMPLE.

In what Time will $49^{\circ} 37'$ and $13''$ of the Equinoctial pass under the Meridian?

Against	{	49°	$0'$	$0''$	—	3^h	$16'$	$0''$	$0'''$
			37	0	—		2	28	0
				13	—			0	52
Answer		49	37	13	—	3^h	18'	28''	52'''

In like manner the Ascensional Difference, being just 26° , answers to $1^h 44'$, which is an Hour and $\frac{4}{5}$ before six, agreeable to the Problem VI.

Prob. XI. To convert TIME into MOTION, or to tell what Number of Degrees, Minutes, and Seconds pass under the Meridian in a given Time.

The Solution of this Problem is likewise most easy by a Table, which we have therefore here inserted :

EXAMPLE.

Suppose it be required to know what Number of Degrees, Minutes, and Seconds, of the Equinoctial, pass under the Meridian in $3^h 18' 28'' 52'''$, the Quantities of Motion taken out of the Second Column, answering to the several Parts of Time in the first Column, being placed apositely, and added together as before, will give the Answer, $49^h 37' 13''$.

0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9
10	10	10	10	10
11	11	11	11	11
12	12	12	12	12
13	13	13	13	13
14	14	14	14	14
15	15	15	15	15
16	16	16	16	16
17	17	17	17	17
18	18	18	18	18
19	19	19	19	19
20	20	20	20	20
21	21	21	21	21
22	22	22	22	22
23	23	23	23	23
24	24	24	24	24
25	25	25	25	25
26	26	26	26	26
27	27	27	27	27
28	28	28	28	28
29	29	29	29	29
30	30	30	30	30
31	31	31	31	31
32	32	32	32	32
33	33	33	33	33
34	34	34	34	34
35	35	35	35	35
36	36	36	36	36
37	37	37	37	37
38	38	38	38	38
39	39	39	39	39
40	40	40	40	40
41	41	41	41	41
42	42	42	42	42
43	43	43	43	43
44	44	44	44	44
45	45	45	45	45
46	46	46	46	46
47	47	47	47	47
48	48	48	48	48
49	49	49	49	49

A TABLE.

A T A B L E.

By which the Longitude exprest in Hours, Minutes, and Seconds, &c. may be reduced to Degrees, Minutes, and Seconds, &c.

Hours.	Degrees.	Min.	Deg. Min.		Min.	Deg. Min.	
		Sec.	Min. Sec.		Sec.	Min. Sec.	
		Th.	Sec. Th.		Th.	Sec. Th.	
1	15	1	0	15	31	7	45
2	30	2	0	30	32	8	0
3	45	3	0	45	33	8	15
4	60	4	1	0	34	8	30
5	75	5	1	15	35	8	45
6	90	6	1	30	36	9	0
7	105	7	1	45	37	9	15
8	120	8	2	0	38	9	30
9	135	9	2	15	39	9	45
10	150	10	2	30	40	10	0
11	165	11	2	45	41	10	15
12	180	12	3	0	42	10	30
13	195	13	3	15	43	10	45
14	210	14	3	30	44	11	0
15	225	15	3	45	45	11	15
16	240	16	4	0	46	11	30
17	255	17	4	15	47	11	45
18	270	18	4	30	48	12	0
19	285	19	4	45	49	12	15
20	300	20	5	0	50	12	30
21	315	21	5	15	51	12	45
22	330	22	5	30	52	13	0
23	345	23	5	45	53	13	15
24	360	24	6	0	54	13	30
		25	6	15	55	13	45
		26	6	30	56	14	0
		27	6	45	57	14	15
		28	7	0	58	14	30
		29	7	15	59	14	45
		30	7	30	60	15	0

Thus

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Thus, against	{	3 ^h	0'	0''	0'''	}	find You	{	45°	0'	0''
		18	0	0	0				4	30	0
			28	0						7	0
				52							13

3 18 28 52 Sum 49 37 13

Prob. XII. To find the Beginning and End of the *Crepusculum*, or TWILIGHT, for any given Day of the Year.

In the Solution of this and the following Problem, the *Quadrant of Altitude* will be necessary, which, therefore, must now be screwed on to the Zenith Point, or so that the *Fiducial Edge* of the Nut may cut 51° 30' of the Meridian, which is the Zenith of *London*, the Globe being supposed rectified for this Metropolis.

It is collected from many Observations that have been made by Astronomers, that the Sun, after its Descent below the Horizon, has its Rays refracted through, and enlightening the Atmosphere near the Earth, till his Depression be equal to about 18°; at the End of which Time, the Atmosphere becomes wholly Dark, at least what we call *dark Night* then begins; and the Time from his setting, 'till his Depression being 18° below the Horizon, is called the *Crepusculum*, or *Twilight*. But when the Sun is 18° below the Horizon, at any Time, the Place in the *Ecliptic* Diametrically opposite to the Sun, is, of Course, 18° above the Horizon: And therefore let us suppose the Sun in the first Degree of *Taurus*, which, by the Calendar, you will see is on the 21st of *April*. The Point of the *Ecliptic* opposite to this is the beginning of *Scorpio*: Therefore, when the Sun, in the first Scruple of *Taurus*, is below the Horizon in the Western Hemisphere, the beginning of *Scorpio* will be 18° above the Eastern Horizon: Consequently, if the *Quadrant of Altitude*, and the Globe be so moved together, 'till the beginning of *Scorpio* coincides with the 18° of the *Quadrant*, then will the Index Point to the Time when the *Twilight* Ends on the 21st of *April*, which will be about 25' after IX, and the Sun sets that Day about VII, as is found by *Problem VI*. Therefore the Length of the Morning and Evening *Twilight*, will, on that Day, be near 2^h 25'.

Prob. XIII. To find the ALTITUDE of the SUN on any given HOUR of the DAY, and Latitude of the Place.

Find the Sun's Place in the *Ecliptic*, bring it to the Meridian, and set the Hour Index to XII; then move the
Globe

Globe about 'till the Index points to the given Hour; and the Quadrant of Altitude being screwed to the Zenith, bring it to lie over the Sun's Place, and the Number of Degrees upon the Quadrant, contained between the Sun's Place and the Horizon, will be the Altitude required. Thus, for Example; on the 11th of May, at IX in the Morning, the Sun's Altitude will be found near 42 Degrees.

N. B. If the Place of the Sun be brought to the Meridian, it is then said to *Culminate*; and its *Meridian Altitude* for that, or any other Day, while it is in the six Northern Signs, will be evidently equal to its *Declination* added to the *Elevation* of the *Equator*, or *Compliment* of the *Latitude*. But, while the Sun is in the six Winter Signs, the Sun's *Declination*, deduced from the *Co-latitude*, will give his *Meridian Altitude*, and *vice versa*.

Prob. XIV. To find the SUN'S AZIMUTH for any given HOUR of the DAY, and Latitude of the Place.

Rectify the Globe, and proceed as directed in the last Problem: then the Angle or Arch of the Horizon contained between the Meridian and Quadrant of Altitude, will be the *Azimuth* of the Sun at the North or South Part of the Horizon, at the given Hour of the Day.

Prob. XV. To find the HOUR of the DAY and the Sun's AZIMUTH, having the Latitude of the Place, the Place of the Sun, and its Altitude known by Observation.

Rectify the Globe, for the Latitude and Place of the Sun, then move the Globe and Quadrant of Altitude so together, that the Sun's Place may cut the given Degree of Altitude on the Quadrant: Then the Index will shew the Hour, and the Quadrant will cut the Azimuth in the Horizon. Thus, at London, on the 11th of May, supposing the Sun's Altitude to be observed in the Forenoon to be 42°, then will the Index point to the Hour of IX, and the Sun's Azimuth is about 63° from the South.

N. B. The Sun's ALTITUDE is easily taken by any QUADRANT having Sights and a Plumb-line; for, holding the Quadrant toward the Sun, so that its Rays, passing through a small Hole in one Sight, may fall exactly on the correspondent Hole on the other, the Plumb-line will cut the Degree on the Limb of the Quadrant equal to the Height of the Sun. But the best and most accurate Method of taking

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the Sun's Altitude, is by a *Hadley's Quadrant* with an *ARTIFICIAL HORIZON*.

Prob. XVI. To find the HOUR of the DAY, when the SUN shines, for any given Latitude and Day of the Month.

Place the Frame of the Globe level, and the Meridian due North and South by the Needle: then Rectify the Globe to the Latitude, and fix a Pin or Needle perpendicular to the Surface of the Globe, in the Place of the Sun, which bring to the Meridian, and fix the Hour Index to XII: then turn the Globe about till the Pin cast no shadow, for it will then be exactly under the Sun, and the Index will shew the Hour of the Day.

Prob. XVII. To find the ALTITUDE of the Sun and Hour of the Day, from the LATITUDE, Place of the SUN, and his AZIMUTH given.

Rectify the Globe for the Latitude, Place of the Sun, &c. then Place the Quadrant of Altitude to the given Azimuth in the Horizon, and move the Globe about till the Sun's Place comes upon the Edge of the Quadrant, which will then shew its Altitude, and the Index will point to the Hour. Thus, suppose at *London* on the 11th of *May*, I observe the Azimuth of the Sun in the Forenoon to be 63° from the South, then having placed the Quadrant of Altitude to that Degree of the Horizon, and brought the Sun's Place, or 21st Degree of *Taurus*, to the Edge of it, it will cut 42° of the Quadrant for the Sun's Altitude, and the Index will point to IX. o'Clock.

Prob. XVIII. To find the LATITUDE of the PLACE, from the given Declination and Meridian ALTITUDE of the SUN.

Mark the Point of Declination upon the Meridian, whether North or South, then slide the Meridian up or down in the Notches till the Point of Declination be so far distant from the Horizon, as is equal to the given Meridian Altitude: then will the Axis of the Earth, or Pole of the World have its proper Height above the Horizon, and shew the true Latitude of the Place. The Reason of this Problem is very evident, from the Note of Problem XIII.

Prob. XIX. To find the ANGLE which the ECLIPTIC makes with the HORIZON, for any HOUR of a given DAY and LATITUDE of the Place.

Rectify the Globe for the Latitude, Sun's Place, and given Hour; then lay the Quadrant of Altitude over the Pole of the Ecliptic, and the Arch of the Quadrant, contained

tained between that Pole and the Zenith, will shew the Number of Degrees in the *Altitude* of the *Ecliptic*, or *Nonagesimal Degree*: Thus on the 11th of *May* at IX in the Morning, the Pole of the *Ecliptic* will be distant from the Zenith $44^{\circ} 30'$, which is equal to the Elevation of the *Ecliptic* above the Horizon at that Time.

Prob. XX. To find the POSITION, or AZIMUTH of the NONAGESIMAL DEGREE of the *Ecliptic*, for any given LATITUDE, and TIME of the DAY.

Let every Thing be done as directed in the last Problem; then observe the Number of Degrees in the Arch of the Horizon, intercepted between the North Point and the Quadrant of Altitude, lying over the Pole of the *Ecliptic*; for that will be the Azimuth of the *Nonagesimal Degree* from the South Point of the Horizon. Thus, for the 11th of *May*, in the Latitude of *London*, at IX in the Morning, it will be about 35 Degrees.

Prob. XXI. To find the POINT of the ECLIPTIC, which is the NONAGESIMAL DEGREE, for any given TIME of the DAY, and LATITUDE of the Place.

Having found the Azimuth of the *Nonagesimal Degree* by the last Problem, bring the Quadrant of Altitude to cut the South Part of the Horizon in the same Number of Degrees, while the Hour-hand points at the given Time; then will the Edge of the Quadrant intersect the *Ecliptic* in the *Nonagesimal Degree* required, which for the 11th of *May*, at IX. in the Morning, at *London*, will be 29° of *Aries*.

N. B. In the six ascending Signs, the *Nonagesimal Degree* is always to the East of the Meridian; but in the six descending Signs, it is to the Westward of it. Note also, the Point called *Medium Cæli*, or *Mid-Heaven*, is that Degree of the *Ecliptic* which *culminates*, or is in the Meridian; and therefore is always known by Inspection, which in this Example is about 5° of *Aries*.

Prob. XXII. To find the DEPRESSION of the SUN below the HORIZON, and the AZIMUTH at any HOUR in the NIGHT, for the GIVEN TIME and LATITUDE of the Place.

Having rectified the Globe for the Latitude, Sun's Place, and Hour of the Night; take a Point in the *Ecliptic* exactly opposite to the Sun's given Place, and then find the Sun's Altitude and Azimuth for that Point, as directed in Prob. XIII. and XIV. and these will be the Depression and the Azimuth required. Thus, for the 11th of *May*, the Sun

being in the 21st of *Taurus*, and turning the Globe about till the Index point at IX at Night, you will observe the opposite Point of the Ecliptic, which is the 21st of *Scorpio*, just as far above the Southern Horizon as the Sun's Place is depressed below the Northern Part: Then bringing the Quadrant of Altitude to lie over that Degree, you will observe its Altitude on the Edge of the Quadrant to be 10° ; and its Azimuth $40^{\circ} 30'$ from the South; and such is the *Depression* of the Sun, and its *Azimuth* from the North, at the given Time.

C H A P. V.

The Use of the CELESTIAL GLOBE in the SOLUTIONS of PROBLEMS concerning the MOON.

THE foregoing Problems are such as relate to the SUN, whose Path is constantly the same in the Heavens. and the Motion of the Nodes of his Orbit not being sensible in a few Years. Solutions of the Problems relative to this Luminary are of the *most simple Kind*, and admit of no Variation in a long Course of Time; But it is far otherwise with respect to the MOON, whose Orbit constantly varies its Position, and the Place of her *Node* is always changing; we do not here speak of its variable Inclination to the Ecliptic, as being too nice an Affair in the *Use of the Globe*.

Again: the Motion of the Moon being very irregular, and *variable* in every Part of its Orbit, this, together with the *Motion of the Orbit itself*, make it impossible to ascertain her Place by any constant Calendar, such as we use for the Sun; but her Place must be previously calculated for *every Day in every Month*, and that for *every particular Year*: Such Calculations disposed in proper Tables, make what is called an *Ephemeris* of the Moon's Motion: but, even in this *Ephemeris*, her Place is only shewn at the Beginning of each Day, or XII o'Clock at Noon. If her Place be required for any other Time of the Day, that must be found by considering what is the Quantity of her *diurnal Motion*, or the Space in the Ecliptic she passes through for that Day. For this Purpose, we shall insert a proper TABLE at Problem XXV. And whereas there have been many Contrivances for re-
presenting

presenting the *variable* PATH, or ORBIT of the MOON, over the Surface of the *Celestial* GLOBE, and some of them both troublesome and expensive, I shall here describe the Method which I have always used myself, and think to be the most natural, easy, and demonstrable of any, which is, by tying fast a *silken* LINE over the Surface of the Globe, exactly on the *Ecliptic*; which may be afterwards removed towards the North, or South, just equal to the Latitude of the Lunar Orbit in the Heavens, and the Points of Intersection with the *Ecliptic* or *Nodes*) will be such, as the Table in the *Ephemeris* assigns for every Sixth Day in the Year.

That Point of Intersection, or NODE of the *Lunar Orbit*, in which the MOON *ascends* from the Southern to the Northern Part, is called the *Ascending Node*, or, (according to the *astrological Cant*) the *Dragon's Head*, and is distinguished by this Character $\oslash$; and the other Node, or *Dragon's Tail*, is represented by the same Character inverted, thus $\oslash$: But this last is not found in the *Ephemeris*, as not being necessary; for the Place of one Node being given, the Place of the other is known, as being diametrically opposite to it.

Prob. XXIII. To find the NODES of the MOON'S ORBIT for any given TIME.

On the first Page. of White's or Parker's *Ephemeris*, published annually, in the Table of *Geocentric* Motions, is a small Table on the Top, containing the *Latitude* of the Planets for every sixth Day; but in the last Column of this Table, towards the Right-hand, are the Numbers which shew the Sign, Degree, and Minutes of the Place of the Node. Thus, for Instance, on the 11th of *May*, 1762, the Place of the ascending Node will be found in $8\ 11^{\circ}\ 34'$; and, therefore, the descending Node will be in the same Degree and Minute of the opposite Sign *Scorpio* m.

N. B. You will find, by this Table, that the Motion of the Lunar Nodes is so very slow as to alter but a few Minutes in a Month, it making one Revolution through the *Ecliptic* in almost 19 Years.

Prob. XXIV. To assign the ORBIT of the MOON its proper POSITION in the Heavens for any given TIME.

Having found the Nodes by the foregoing Problem, reckon from thence 90° each Way in the *Ecliptic*, where you must begin to elevate, or remove the Silk Line, (now lying on the *Ecliptic*) towards each of its Poles, keeping it, without
any

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any Motion, in the *Points of the Nodes*, by a gradual removing the Moon's Orbit from the Ecliptic you will stop at her utmost Latitude, which is $5\frac{1}{4}$ Degrees; which points on either Side of the Ecliptic, are easily determined by the Parallels of Latitude which pass through every Degree, to the extent of the Zodiac, on either Side the Ecliptic. The *Silk-line*, in this Position will duly represent the Lunar ORBIT in the Heavens for that Day.

Prob. XXV. *To find the Moon's DIURNAL MOTION, in the ECLIPTIC, for any given DAY.*

Find her Place for the given Day at Noon in the second Column of daily Geocentric Motions, and subtract from it her Place on the preceding Day at Noon, and the Difference will be the Space she has described for that Day, and is the *Quantity of the Diurnal Motion* sought. For Example, let her Diurnal Motion be required for the 11th of May, 1762.

On the 11th of May her Place is	0°	17'
On the 10th of May	17	45

The Diurnal Motion sought	12°	32'
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Now the Diurnal Motion of the Moon being variable from $11^{\circ} 46'$ when *least*, to $15^{\circ} 16'$, when *greatest*; I have added the following Table containing the *Diurnal Motions*, from the least to the greatest, which differ only by $10'$, in 22 different Columns; of Course, upon the Top of one of these you will observe the Diurnal Motion, just now found, pretty nearly; and the 24 Hours being placed by the Side of the Table, it will be easy from thence, to see what Part of the Diurnal Motion of the Moon answers to any given Number of Hours. Thus, for the Diurnal Motion above found of $12^{\circ} 32'$, you will find, on the Top of the 6th Column, $12^{\circ} 36'$, and under it, against the 9^h, you will find $4^{\circ} 43'$, which is her Motion in the Ecliptic in the Space of 9 Hours for that Day.

Prob. XXVI. *To find the MOON'S PLACE in the Ecliptic for any given HOUR of the DAY.*

Look in the second Column of the large Table of the daily *Geocentric Motions*, and you will find opposite to the given Day of the Month, the Moon's Place in the Ecliptic for that Day at Noon; and, by the foregoing Problem, find the Space she has described since Noon to be the given Moment of Time, which, added to the former, will be her Place in the Ecliptic, as required for the present Moment: Thus on the

A TABLE for finding the hourly Motion of the Moon, and thereby her true Place at any Time of the Day.

Hour	11 46	11 56	12 6	12 16	12 26	12 36	12 46	12 56	13 6	13 16	12 26
	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.
1	0 29	0 30	0 30	0 30	0 31	0 31	0 32	0 32	0 33	0 33	0 34
2	0 59	1 0	1 0	1 1	1 2	1 33	1 4	1 5	1 5	1 6	1 13
3	1 28	1 20	1 31	1 32	1 33	1 35	1 36	1 37	1 38	1 39	1 41
4	1 58	1 59	2 1	2 3	2 4	2 6	2 8	2 9	2 11	2 13	2 14
5	2 27	2 29	2 31	2 34	2 35	2 37	2 40	2 42	2 44	2 46	2 48
6	2 57	2 59	3 1	3 4	3 6	3 9	3 11	3 14	3 16	3 19	3 21
7	3 26	3 29	3 32	3 35	3 38	3 40	3 43	3 46	3 49	3 52	3 55
8	3 55	3 59	4 2	4 6	4 9	4 12	4 15	4 19	4 22	4 25	4 28
9	4 25	4 28	4 32	4 36	4 40	4 43	4 47	4 51	4 55	4 58	5 2
10	4 54	4 58	5 3	5 7	5 11	5 1	5 19	5 23	5 27	5 32	5 56
11	5 24	5 28	5 33	5 37	5 42	5 4	5 51	5 56	6 0	6 3	6 9
12	5 53	5 58	6 3	6 8	6 13	6 18	6 23	6 28	6 33	6 38	6 43
13	6 22	6 28	6 33	6 39	6 44	6 49	6 55	7 0	7 6	7 11	7 17
14	6 52	6 58	7 3	7 9	7 15	7 21	7 27	7 33	7 38	7 44	7 50
15	7 21	7 27	7 34	7 40	7 46	7 52	7 59	8 5	8 11	8 17	8 24
16	7 51	7 57	8 4	8 11	8 17	8 24	8 31	8 37	8 44	8 51	8 57
17	8 20	8 27	8 34	8 41	8 48	8 55	9 3	9 10	9 17	9 24	9 31
18	8 49	8 57	9 4	9 12	9 19	9 27	9 34	9 41	9 49	9 57	10 4
19	9 19	9 26	9 35	9 43	9 51	9 58	10 6	10 14	10 22	10 30	10 38
20	9 48	9 56	10 5	10 13	10 21	10 30	10 38	10 47	10 55	11 3	11 12
21	10 17	10 26	10 36	10 44	10 53	11 1	11 10	11 19	11 27	11 36	11 45
22	10 47	10 56	11 6	11 15	11 21	11 33	11 42	11 51	12 0	12 10	12 19
23	11 17	11 26	11 36	11 46	11 55	12 4	12 14	12 24	12 33	12 43	12 52
24	11 46	11 56	12 6	12 16	12 26	12 36	12 46	12 56	13 6	13 16	13 26

the 10th of *May* her Place at Noon will be found in $17^{\circ} 45'$ of $\uparrow$, and since her Motion for that Day is $12^{\circ} 32'$, in nine Hours she will have passed over $4^{\circ} 43'$, which added to her Place at Noon, will give $22^{\circ} 21'$ of $\uparrow$ for her Place on the 10th of *May* at IX at Night.

Prob. XXVII. To find the MOON'S PLACE in her ORBIT for any given DAY and HOUR.

Having found her Place in the *Ecliptic* by the preceding Problem, you are to observe, that through every Degree of the *Ecliptic*, perpendicular thereto, are drawn in the *Zodiac*, *Circles of Latitude*: Then that Circle which passes through the Moon's Place in the *Ecliptic* will intersect the *Silken-line*, and, thereby, shew her true Place in that *Artificial Orbit*, which may be denoted by a Piece of Paper cut from the Copper Plate Print given with the Globes, in Form of a *Crescent*, and placed upon the said Line, where we suppose it to remain during the Course of these Problems, which

A TABLE for finding the hourly Motion of the Moon, and thereby her true Place at any Time of the Day.

	13 30	13 40	13 50	14 6	14 16	14 26	14 36	14 46	14 56	15 6	15 16
	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.
1	0 31	0 34	0 36	0 36	0 36	0 36	0 36	0 37	0 37	0 38	0 38
2	1 8	1 9	1 16	1 10	1 11	1 12	1 13	1 14	1 15	1 15	1 16
3	1 42	1 42	1 46	1 46	1 47	1 48	1 49	1 51	1 51	1 53	1 54
4	2 16	2 8	2 19	2 21	2 23	2 24	2 26	2 28	2 29	2 31	2 33
5	2 50	2 52	2 54	2 56	2 58	3 0	3 3	3 5	3 7	3 9	3 11
6	3 24	3 26	3 29	3 31	3 34	3 39	3 39	3 41	3 45	3 46	3 9
7	3 58	4 1	4 4	4 7	4 10	4 10	4 13	4 18	4 21	4 24	4 7
8	4 32	4 35	4 39	4 42	4 45	4 49	4 52	4 55	4 59	5 2	5 5
9	5 6	5 10	5 13	5 17	4 21	5 25	5 28	5 32	5 36	5 40	5 43
10	5 40	5 42	5 48	5 52	5 57	6 1	6 5	6 9	6 13	6 17	6 22
11	6 14	6 19	6 23	6 28	6 32	6 37	6 41	6 46	6 51	6 55	7 0
12	6 48	6 53	6 58	7 3	7 8	7 13	7 28	7 23	7 28	7 33	7 28
13	7 22	7 27	7 33	7 38	7 44	7 49	7 54	8 6	8 5	8 11	8 10
14	7 56	8 0	8 8	8 13	8 19	8 25	8 31	8 37	8 43	8 48	8 54
15	8 30	8 36	8 42	8 49	8 55	9 1	9 7	9 14	9 20	9 26	9 32
16	9 4	9 11	9 17	9 21	9 12	9 37	9 44	9 51	9 57	10 4	10 11
17	9 38	9 45	9 52	9 59	10 20	10 13	10 20	10 28	10 33	10 42	10 49
18	10 12	10 19	10 27	10 34	10 42	10 49	10 57	11 4	11 12	11 19	11 27
19	10 46	10 54	11 5	11 10	11 18	11 26	11 34	11 41	11 49	11 57	12 5
20	11 29	11 38	11 37	11 24	11 8	12 2	12 10	12 18	12 17	12 35	12 42
21	11 58	12 3	12 11	12 20	12 9	12 38	12 40	12 55	13 4	13 13	13 21
22	12 28	12 37	12 46	12 55	13 5	13 14	13 23	13 33	13 41	13 50	13 50
23	13 2	13 12	13 21	13 31	13 43	13 50	13 59	14 9	14 10	14 28	14 38
24	13 26	13 46	13 56	14 6	14 16	14 26	14 36	14 46	14 56	15 6	15 16

which will all have regard to the 10th of *May* at IX o'Clock at Night.

Prob. XXVIII. To find the LATITUDE of the MOON for any given DAY and HOUR.

Having found her Place in the *Ecliptic*, and also in her Orbit, the Arch of a Circle of Latitude between these two Points, will be the Quantity of her Latitude sought, and is easily seen in Degrees and Parts of a Degree on the *Zodiac* of the Globe. Thus, for the 10th of *May*, 1762, at Noon, her Latitude is $3^{\circ} 7'$, the same as you will observe in the third Column of *Geocentric Motions* against the given Day.

N. B. In the Column of Latitudes you will see the Letter A, denoting the *South* LATITUDE, and the Letter B denoting the *North* Latitude; and by these you will easily see when the Moon is in either *Node*, as there she has no Latitude at all.

Prob.

Prob. XXIX. To find the MOON'S DECLINATION for any given DAY or HOUR.

The Place in her Orbit being found, by Problem XXVIII, bring the *Crescent* to the *General Meridian*: Then the Arch of the Meridian, contained between it and the Equinoctial, will be the *Declination* sought, which, in the foregoing Example on the 10th of May at Noon, 1762, will be about 25° .

Prob. XXX. To find the MOON'S greatest and least MERIDIAN ALTITUDES in any given LATITUDE, that of LONDON, for Example.

It is evident, this can happen only when the *ascending Node* of the MOON is in the *vernal Equinox*; for then her greatest *Meridian ALTITUDE* will be 5° greater than that of the Sun, and therefore about 67° : also her least *Meridian Altitude* will be 5° less than that of the Sun, and therefore only 10° : there will therefore be 57° *Difference* in the *Meridian Altitude* of the Moon; whereas, that of the Sun is about 47° .

N. B. When the same *ascending Node* is in the *autumnal Equinox*, then will her *Meridian Altitudes* differ by only 37° : But these *Phænomena* can separately happen but once in the revolution of a Node, or of *nineteen Years*: And it will be a pleasant Entertainment to place the Silk-line to cross the *Ecliptic* in the Equinoctial Points *alternately*; for then the Reason will more evidently appear, why you observe the Moon sometimes within 23° of our *Zenith*, and at other Times not more than 10° above the *Horizon*, when she is full South.

Prob. XXXI. To find the Time of the MOON'S RISING, SOUTHING, and SETTING, for any LATITUDE and given DAY of the YEAR.

First, rectify the Globe for the Latitude of the Place, and find the Moon's Place in her Orbit at Noon, for the given Day, which bring to the General Meridian, and set the Hour Index at XII; Then bring her Place to the Eastern Part of the Horizon, and the Index will shew the Time of her Semi-diurnal Arch, supposing the Moon were fixed in her Orbit; but as she is not, the Quantity of her Motion, during the Time of that Semi-diurnal Arch, must be found and subtracted from her Place at Noon, in order to give her Place in her Orbit pretty nearly at rising; and the same Motion must be added to her Place at Noon, in order to give her Place in her Orbit at setting. Thus, for Example: on the 10th of May, 1762, at London the Moon's Place was

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found

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found in 18° of *Sagittarius*, which will give the Semi-diurnal Arch about 4° , in which Time the Motion of the Moon will be about 2° ; therefore her Place, at rising, will be 16° of that Sign, and her Place at setting about 20° .

Secondly, find the Sun's Place for the 10th of *May* at Noon, bring it to the Meridian, and set the Hour Index to XII: Then turn the Globe about till the 16° of *Sagittarius* coincides with the *Eastern* Part of the Horizon; then will the Index Point to nearly Half an Hour after X at Night, which will be the Time of her *rising*. Then bring the 18° of the same Sign to the Meridian, and the Index will point to II in the Morning for the Time of her *Southing*. Lastly, the 20° of *Sagittarius*, being brought to the *Western* Part of the Horizon, will shew the Time of her *setting* about a $\frac{1}{4}$ after V in the Morning.

Prob. XXXII. *To find the AMPLITUDE, AZIMUTH, ALTITUDE, &c. &c. of the Moon for any given DAY, HOUR, and LATITUDE of the PLACE.*

When the Place of the Moon in her Orbit is found for the given Day and Hour, and the Globe rectified for the given Latitude, then the *Amplitude, Azimuth, Altitude, &c.* of the MOON will be found in the same Manner as directed for those of the SUN, *viz.* by observing the Degrees of the Horizon in which the Moon rises and sets on the given Day; and by laying the Quadrant of Altitude (fixed in the Zenith) over the Moon's Place, or *Crescent*, when in any Position above the Horizon, or else over the Point of the Moon's Orbit exactly opposite to it, when it is depressed below it.

Prob. XXXIII. *To explain the Phænomena of the HARVEST, or SHEPHERDS MOON.*

What is usually called the HARVEST MOON is the *full Moon* that happens when the Sun is near the *autumnal EQUINOX*, which every Night successively rises within a very short Time of the Sun's setting, by which Means the Hemisphere becomes almost constantly enlightened by one Luminary or the other: whence it happens, that the Nights become very lightsome and pleasant, and therefore, very advantageous for *Harvest* People, *Shepherds, Sportsmen, &c.* on which Account it receives those various Appellations.

On the contrary, at the opposite Time of the Year, or *vernal EQUINOX*, a considerable Time elapses between the setting of the Sun and rising of the full Moon; thereby occasioning the Nights to be dark even at the Time of a full Moon:

Moon: The Reason of all which will very easily appear, by only considering the very different Angle which the Ecliptic makes with the Horizon at those two opposite Seasons of the Year: For in the Latitude of LONDON, at the Time of the *vernal Equinox*, when the Sun is setting in the Western Part of the Horizon, the Ecliptic then makes an Angle of 62° with the Horizon; but when the Sun is in the *autumnal Equinox*, and setting in the same Western Part of the Horizon, the Ecliptic makes an Angle but of 15° with the Horizon: All which is evident by a bare Inspection of the Globe only.

Again, according to the greater or less *Inclination* of the Ecliptic to the *Horizon*, so a greater or less Degree of Motion of the Globe about its Axis will be necessary to cause the same Arch of the Ecliptic to pass through the Horizon; and, consequently, the Time of its Passage will be greater, or less, in the same Proportion: But this will be best illustrated by an Example.

Therefore, suppose the Sun in the *vernal EQUINOX*, and rectifying the Globe for the Latitude of *London*, and Place of the Sun, bring the *vernal Equinox*, or Sun's Place to the Western Edge of the Horizon, and the Hour Index will point precisely to VI; at which Time, we will also suppose the Moon to be in the *Autumnal Equinox*, and, consequently, at *Full*, and *rising* exactly at the same Time of *Sun-set*.

But on the following Day, the Sun, being advanced scarcely one Degree in the Ecliptic, will set again very nearly at the same Time as before: But the Moon will, at a mean Rate, in the Space of one Day, pass over 13° in her Orbit; and therefore, when the Sun sets in the Evening after the Equinox, the Moon will be below the Horizon, and the Globe must be turned about till 13° of *Libra* comes up to the Edge of the Horizon, and then the Index will point to $7^h\ 16'$, the Time of the Moon's rising; which is an Hour and $\frac{1}{4}$ after Sun-set. The next day following, there will be 2^h and $\frac{1}{2}$, and so on successively, with an increase of 1^h and $\frac{1}{4}$ Dark-night each Evening respectively, at this Season of the Year; all owing to the very great Angle which the Ecliptic makes with the Horizon at the Time of the Moon's rising.

On the other Hand, suppose the Sun in the *Autumnal EQUINOX*, or beginning of *Libra*, and the Moon opposite to

it in the vernal Equinox, then the Globe (Rectified as before) being turned about till the Sun's Place comes to the Western Edge of the Horizon, the Index will point to VI, for the Time of his *setting*, and the rising of the *Full-moon* on that Equinoctial Day. On the following Day, the Sun will set nearly at the same Time; but the Moon being advanced (in the 24 Hours) 13° in the Ecliptic, the Globe must be turned about till that Arch of the Ecliptic shall ascend the Horizon, which Motion of the Globe will be very little, as the Ecliptic now makes so small an Angle with the Horizon, as is evident by the *Index*, which now points to VI^h 17' for the Time of the Moon's rising on the second Day, which is but about $\frac{1}{4}$ of an Hour after Sun-set. The third Day, the Moon will rise within $\frac{1}{2}$ an Hour; on the 4th, within $\frac{3}{4}$ of an Hour, and so on; so that it will be near a Week before the Nights will be an Hour without Illumination: and in greater Latitudes this Difference will be still greater, as you will easily find by varying the Case, in the Practice of this celebrated Problem, on the Globe. This Phænomenon will be also variable by the *different Position* of the Moon's Orbit at different Times.

Prob. XXXIV. *To find the TIMES of the YEAR when the SUN and the MOON are subject to be ECLIPSED.*

Were the MOON to describe the same Path in the Heavens with the SUN, or if she always moved in the *Ecliptic*, there would always be a *central and total ECLIPSE* of the SUN in every *Conjunction*, and a *central Eclipse* of the MOON at every *Opposition*; and these Eclipses would alternately return every *Fortnight*.

But, as the Case now stands, the Moon's Orbit not coinciding with the Ecliptic, but making an Angle of 5° therewith, there can be but *two Points* in the Ecliptic in which she can be found in a whole LUNATION; and as these two Points, or NODES of the Moon's Orbit, are diametrically opposite to each other, there are but *two Days* in the YEAR when it is possible for the Sun and Moon to be both together in the same Point of the Ecliptic, and, Consequently, that a *central, or total ECLIPSE* of the SUN can happen.

Now these two Days may be easily determined by finding the Places of the Moon's Nodes for the given Year, by Prob. XXIV, and then, when the Sun possesses that Degree of the Ecliptic, see what Days in the Month correspond thereto

thereto in the Calendar, for they are the Times required for a central Eclipse of the Sun.

Thus, for Instance ; in the Year 1762, the *ascending Node* was in the $11^{\circ} 34'$ of 8, and the *descending Node* in the same Number of Degrees of 3 : By the Calendar I observe, the Sun is in those Points of the *Ecliptic*, on *May* the 1st, and *November* the 3d ; but on those Days our Almanack mentions no Eclipses, the Reason of which is, that, when the Moon passed her Nodes, the Sun was at some small Distance from them, and the Eclipses of the Sun, in such a Case, could be only *partial*. Thus, the Moon past the *ascending Node* in that Year, on the 24th of *April*, when the Sun was about 6° distant from the Node, as is evident by the *Ephemeris* for the Month of *April*. The same you will likewise observe for the Eclipses in *November*, at the *descending Node*.

By the Doctrine of Eclipses it is found, that the Sun must be within 12° of the Node to suffer an Eclipse in any Degree ; and the Moon within 16° , otherwise she cannot enter the Earth's Shadow. These Distances are, therefore, called the *Ecliptic Limits* for *solar* and *lunar* ECLIPSES ; because beyond these, the *Latitude* of the Moon will be too great to admit of any Eclipses.

See this curious Part of Astronomy explained at large in MARTIN'S *Philosophia Britannica* ; with all the *Mathematical* ELEMENTS and CALCULATIONS. You may also find much on the same Subject in the Young GENTLEMAN AND LADIES PHILOSOPHY, Third Edition.

C H A P. VI.

The Use of the CELESTIAL GLOBE in the SOLUTION of PROBLEMS relative to the various Phænomena of the PLANETS.

HAVING dispatched the Problems relative to the SUN and MOON, we come now to those of the PLANETS. In the Solution of *Planetary* PROBLEMS, the signal and important Use of the Celestial Globe will be no less conspicuous than in the former, and must be very entertaining and advantageous, as by this Means we are always enabled to find how many, and what Planets are *above the Horizon* ; and,

and, consequently, the proper Subjects for our *Inspection* and *Observation* at any given Time of the Year.

But, as the Motion of some of the Planets are very quick, and even those of the slowest are very sensible in the Space of 12 Months, therefore it becomes necessary, by previous Calculation, to have their Places ascertained for every Day in the Year, (in the same Manner as for the Moon) in an *Ephemeris*; and hence it is we find *five several Columns* following that of the Moon's Latitude in the Table of Geocentric Motions, appropriated to the *five PLANETS* respectively, shewing the *Sign, Degree, and Minute* of the Ecliptic which each Planet possesses on the Noon of every Day throughout the Year. This is evident by Inspection of the *Ephemeris*.

The INCLINATIONS of the *Planetary ORBITS*, or the *Angle* they make with the Ecliptic, is, in general, so small as not to be regarded, except only for *Mercury*; and therefore the silk String, which was used for the Moon's Orbit, is not here necessary. The Problems, therefore, peculiar to the Planets, are but very few, and their Solutions are as follow:

Prob. XXXV. *To find the PLACE of the given PLANET in the ECLIPTIC for a given TIME.*

Look for the given Month in the *Ephemeris*, and opposite to the given Day of the Month is the Planet's Place in the Ecliptic, in the Column proper to that Planet. Thus, for Example: On *May 9th, 1762*, you will find

<i>Saturn's Place at Noon is</i>	♄	18	26
<i>Jupiter's</i>	♃	24	48
<i>Mar's</i>	♂	16	46
<i>Venus's</i>	♀	29	30
<i>Mercury's</i>	☿	0	31

Having found these Places, you stick the Paper Planets on the respective Points in the Ecliptic, to denote them.

Prob. XXXVI. *To find the PLACE of a PLANET in its proper ORBIT.*

Having found the Planets Place in the Ecliptic, you will take out of a small Table, on the Top of the Page, the Numbers proper to the Planet for the Day of the Month, nearest to that of the given Day: This is the Planet's LATITUDE, *North* or *South*, according as the Letters N. or S. stand above it. This Quantity of the Latitude is to be set off in the Circle of Latitude in the Planet's given Place, towards

towards the North or South Pole of the Ecliptic, as the said Letter N or S directs, and that is the Planet's true Place in its Orbit. Thus on the 9th of *May*, 1762, I find the Latitude, in the Column for *Saturn* answering to the 7th Day, to be $2^{\circ} 16'$ South, which, therefore, is nearly the same on the 9th, and consequently gives the Planet's Place in the *Southern Part* of his Orbit. On this Point, therefore, the patch must be put to represent the Planet's Place truly on the Surface of the Globe.

N. B. Though the *Geocentric* or *Apparent Latitudes* of *Saturn* and *Jupiter* are nearly the same as their *real Latitude*, yet, that of *Mercury* will always be less, being seldom more than $4^{\circ} 30'$. On the contrary, that of *Venus* and *Mars* will sometimes much exceed the two *Latitudes*, as being at those Times much nearer to us than to the Sun.

Prob. XXXVII. To find the TIME when a given PLANET RISES, CULMINATES, or SETS on a given Day of the Year, and in a given Latitude.

Rectify the Globe for the Latitude of the Place, bring the Sun's Place for the given Day to the Meridian, and set the Hour Index to XII: Then having found the Planet's Place, bring it to the Eastern Edge of the Horizon, and the Index will point out the Time of its rising. Then bring the said Place, or Patch, to the Meridian, the Index will then shew the Time of its Culminating, or being full South. Lastly, turn the said Patch into the Western Edge of the Horizon, and the Index will there shew the Time of its setting.

For Example: On the 9th of *May*, 1762, at *London*, the Place of the Planet *Jupiter* was in $\Upsilon 24^{\circ} 48'$: Then rectifying the Globe, bring the said Place Western to the Horizon, and the Index will point to III Hours 20', the Time of his rising in the Morning: Then, revolving the Globe till the said Point comes to the Meridian, the Index will shew the Time of its Culmination to be 15' after X; and bringing the said Place to the Western Part of the Horizon, the Index will point to 15' after V, the Time of the Planet's setting.

From all which it evidently appears, that at that Time *Jupiter* was not to be observed in the *Evening*, and but a very little Time in the *Morning*; for as he rose but about half an Hour before the Sun, neither his Altitude nor the *Aurora* would permit his being viewed to any Advantage. And thus

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thus this Problem repeated for each of the Planets, will shew which of them are, or are not, in a Position to be seen on any given Night in the Year.

Prob. XXXVIII. *To find directly the PLANETS which are ABOVE the HORIZON at SUN SET, upon any given DAY and LATITUDE.*

Find the Sun's Place for the given Day, bring it to the Meridian, set the Hour Index to XII, and elevate the Pole for the given Latitude: then bring the Place of the Sun to the *Western Semi-Circle* of the Horizon, and observe what Signs are in that Part of the Ecliptic above the Horizon, then cast your Eye upon the *Ephemeris* for that Month, and you will at once see what Planets possess any of those *elevated Signs*; for such will be *visible*, and fit for Observation on the Night of that Day.

Thus, for Example: On the 9th of *May*, the Sun being in $19^{\circ} 00'$ of γ and in the Western Horizon, will be *Gemini, Cancer, Leo, Virgo, Libra, and Scorpio*: But in the *Ephemeris* you will see only one of those Signs possessed by a Planet, which is *Mars*, who is then in $\approx 16^{\circ} 46'$ in the *Eastern Hemisphere*.

But then, two Signs more may be added for the Planets that may arise *before Mid-night* for that Day, which added to the former, make eight; but no Planet is found in them; therefore *Mars* will be the only Planet to be seen that Night.

Prob. XXXIX. *To find when any of the three superior PLANETS will RISE at SUN-SET, in a given Latitude.*

Rectify the Globe for the Latitude, and in the *Ephemeris* find the Planet's Place, which bring to the Eastern Part of the Horizon, then the Point of the Ecliptic, exactly opposite to the Planet's Place, will be the Western Part of the Horizon; and when the Sun comes to be in that Point, it will, of Course, set when the Planet rises on that Day; and in the Calendar it may be seen, when the Sun possesses that Part of the Ecliptic, which will be the time required.

But this is very easy to be observed in the *Ephemeris* only, by taking Notice of that Time of the Year when the Sun and the Planet possess two opposite Points in the Ecliptic; for, in this opposition, the Planet must rise when the Sun sets.

Thus, for Example: On the 29th Day of *October*, the Sun

Sun and *Jupiter* will be in *Opposition*, and consequently the *Planet* will rise when the Sun sets.

But as to *Venus* and *Mercury*, as one is never seen to depart from the Sun more than about $47^{\circ} 00'$, and the other not more than about 21° , the Times of their rising at Sun-set will be easy to observe, among the Tables of mutual Aspects, on the Right-hand Pages of the *Ephemeris*.

Prob. XL. *To find the right ASCENSION, DECLINATION, AMPLITUDE, AZIMUTH, ALTITUDE, HOUR of the NIGHT, &c. of any given PLANET, for a Day of a Month and Latitude given.*

Rectify the Globe for the given Latitude and Day of the Month, then find the *Planet's Place*, as directed; and then the *right Ascension, Declination, Amplitude, Azimuth, Altitude, Hour, &c.* are all found, as directed in the Problems for the Sun; there being no Difference in the Process, no Repetition can be necessary.

But lest any of our Readers should have the Curiosity of performing these Problems according to the precise Truth, and would chuse to represent their Orbits by a silk String, or Thread, as was directed in the Case of the Moon, it will be necessary to give here the Places of the Nodes, and Inclination of the Orbit, for each particular Planet, as below:

The Place of the <i>Ascend- ing</i> NODE of the Orbit of	<i>Mercury</i>	8	16	2
	<i>Venus</i>	11	14	46
	<i>Mars</i>	8	18	30
	<i>Jupiter</i>	6	8	57
	<i>Saturn</i>	6	21	35
The INCLINA- TION of the Or- bit of	<i>Mercury</i>		6	54
	<i>Venus</i>		3	24
	<i>Mars</i>		1	52
	<i>Jupiter</i>		1	20
	<i>Saturn</i>		2	30

C H A P. VII.

The Use of the CELESTIAL GLOBE in the SOLUTION of PROBLEMS relative to the fixed STARS.

WE now proceed to those Problems on the Celestial Globe in which the STARS are concerned, which, with respect to the present Age, we may very well consider

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as *fixed*, since their Motion is so exceeding slow, as not to be sensible in less than *Half a Century*: And as their Places are carefully rectified on the Globe, and we intend not here a Philosophical Discourse on the Stars, shall only observe, that they are ranged into various CONSTELLATIONS on the Surface of the *Celestial GLOBE*, as artificial Helps for directing us how to know, and where to find them in the Heavens. The *Names* of these *Constellations* are to be learnt by Inspection of the Globe, where they appear very plain; as also their Forms and Disposition; you will find the Stars depicted in different Degrees of *Magnitude*, as they appear to the Eye, the largest being called Stars of the *first Magnitude*; and upon the Globes you will see them decreased to the 6th or 7th *Magnitude*. Whenever you are to perform any Problem of the Stars on the Globe, it is supposed that you have *rectified the Globe* for the *Latitude* of the Place, and for the *Sun's Place* for the given Day at Noon, as in all the other Problems, and then the Process will be very easy and short.

XL I. To find the right ASCENSION and DECLINATION of any given STAR.

Bring the given Star to the Meridian, and the Degree under which it lies, is its *Declination*; and the Point in which the Meridian intersects the Equinoctial, is its right *Ascension*. For instance, let *Arcturus* be the given Star, this brought to the Meridian will be seen under the $20^{\circ} 20'$, which is therefore its *Declination, North*; and its right *Ascension* is, at the same Time, shewn in the Equinoctial to be $211^{\circ} 00'$. Again, another Instance may be *Sirius*, the *Dog-star*, which brought to the Meridian, will be seen under the $16^{\circ} 30'$, which is his *Declination South*; and its right *Ascension* $98^{\circ} 20'$ in the Equinoctial Line.

Prob. XLII. To find the LATITUDE and LONGITUDE of a given Star.

Bring the POLE of the *Ecliptic* to the Meridian, over which fix the Quadrant of Altitude, and, holding the Globe very steady, move the Quadrant to lie over the given Star, and it will cut that Degree in the Edge as will shew its *Latitude* from the *Ecliptic*, and in the *Ecliptic* that Quadrant will cut that Degree which is called its Place reduced to the *Ecliptic*, or LONGITUDE from the Beginning of *Aries*. Thus, with respect to *Arcturus*, its *Latitude* from the *Ecliptic* will be found $30^{\circ} 30'$ and its *Longitude* in the *Ecliptic* about $20^{\circ} 20'$ of *Libra*. This Problem regards either Pole,

Pole, as the Stars are in the Northern or Southern Hemispheres respectively.

Prob. XLIII. *The Right ASCENSION and DECLINATION of a Star being given, to find its Place on the Globe.**

Turn the Globe till the Meridian cuts the Equinoctial in the given Degree of right Ascension: Thus, for Example: suppose you find in the Table the right Ascension of *Aldebaran* to be $65^{\circ} 30'$, and its Declination to be 16° North; then turn the Globe about till the Meridian cuts the Equinoctial in $65^{\circ} 30'$, and under the 16° of the Meridian, on the Northern Part, you will observe the Star *Aldebaran*, or the *Bull's Eye*.

Prob. XLIV. *To find the Time of the rising, southing, setting, Amplitude, &c. of any STAR in a given LATITUDE and DAY of the YEAR.*

The Precept is the same as in the Problems for the Sun. Thus, let it be required to know at what Time the *Pleiades* (or *Seven-stars*) rise, set, &c. in the Latitude of *London*, on the 11th of *May*. The Globe being rectified for the Latitude of *London*, and the sun's Place for the given Day, turn the Globe about till you bring the *Pleiades* into the Eastern Semi-circle of the Horizon, and the Index will Point to IV. 15', the Time of their rising in the Morning.—Then bring the said Cluster of Stars to the Meridian, and the Index will point to about $\frac{1}{2}$ after XII for the Time of their culminating, or being upon the Meridian.—Lastly, bring them to the Western Horizon, and the Index will point to VIII. 30', which shews the Time of their setting in the Evening of that Day.—It will also appear, on the Circle of the Horizon, that they rise with about 40° of Amplitude to the North, and set with the same Amplitude from the West.

Prob. XLV. *To find when a STAR RISES and SETS COSMICALLY, in a given LATITUDE.*

Rectify the Globe to the Latitude of the Place, and bring the given Star to the Eastern Part of the Horizon, then observe what Point of the Ecliptic rises with it, and find the same Degree of the Ecliptic upon the Frame of the Horizon, against which is the Day of the Month when the given Star rises *Cosmically*.—Afterwards, bring the given Star to the

* See the Table of right Ascension and Declination of the Stars at the End of this Chapter.

Western Edge of the Horizon, and observe what Degree of the Ecliptic rises in the Eastern Part, then the Day of the Month in the Calendar, which answers to that Degree, is the Time when the Star *sets Cosmically*.

For Example: *Mencar*, in the *Whale's Mouth*, rises with the 10° of *Gemini*, in the Latitude of *London*, and therefore *rises Cosmically* on the first Day of *June*. Again, by bringing the Star *Mencar* to the Western Part of the Horizon, I find the 2° of *Sagittarius* rising in the East, answering to which is the 24th of *November*, the Time on which that Star *sets Cosmically*.

Prob. XLVI. To find the TIME when any STAR will RISE or SET ACRONICALLY, in a given Latitude.

The Example will here be sufficient: Therefore, let *Sirius* or the *Dog-Star*, be brought to the Eastern Edge of the Horizon, and then observe what Degree of the Ecliptic is in the Western Part of the Horizon, which you will find to be the 18° of *Aquarius*, against which is the 7th Day of *February* in the Calendar, the Time when the *Dog-Star* rises *Acronically*, or at *Sun-set*, and, consequently, when it begins to be *visible in the Evening*.

Then, for the *Acronical setting* of the *Dog-star*, turn the Globe about till he is setting in the Western Horizon, and see what Degree of the Ecliptic is, at the same Time, setting with him, which you will find is the 23° of *Taurus*; and therefore, about the 13th of *May*, this Star *sets Acronically*, or with the Sun, and consequently is no longer to be seen in the Evening.

Hence it is plain, those Months of the Year which intervene between the Acronical rising and setting of the Star, is the Space of Time in which that Star may be seen above the Horizon, of the given Latitude, in an Evening.

Prob. XLVII. To find when any STAR CULMINATES, or comes upon the Meridian with the SUN.

Bring the given Star to the Meridian, and observe what Degree of the Ecliptic comes upon the Meridian with it, and against that Degree is the Day of the Month, in the Calendar required.

For Example: Let the given Star be *Cor Hydra*, which bring to the Meridian, and you will observe the 16° of *Leo* intersected by the Meridian at the same Time; against which in the Calendar, is the 9th Day of *August*, which
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is the Day required, when that Star Culminates with the Sun.

Prob. XLVIII. *To find at what Time of the Year a Star is upon the Meridian at Mid-night.*

Bring the given Star to coincide with the *nocturnal Part* of the Meridian, and then observe what Point of the Ecliptic is intersected by the *diurnal Part* of the Meridian, and the Day when the Sun possesses that Part of the Ecliptic, which you will see, by the Calendar, is the Time required. Thus, for Example: the Star called *Deneb*, in the Tip of the *Great Bear's Tail*, being brought to the *nocturnal Meridian*, the Degree of the Ecliptic lying under the South Semi-circle of the Meridian, is the 26° of *Aries*, against which is the 16th Day of *April*, the Day of the Month on which that Star will be on the Meridian at XII at Night.

Prob. XLIX. *To find the OBLIQUE ASCENSION of a given Star, and thereby the Time of its being above the Horizon in a given Latitude.*

This Problem is performed in the Manner already prescribed for the Sun, Moon, and Planets. Thus, for *Aldebaran*, rectify the Globe to the given Latitude, and you find its right Ascension, by Prob. XLIII, to be $65^{\circ} 30'$; by bringing the Star to the Eastern Horizon, his oblique Ascension will appear to be $41^{\circ} 30'$: the ascensional Difference therefore is 24° ; which converted into Time, is $1^h 36'$, which, added to 6^h , makes 7^h and $36'$, the half Time which that Star is above the Horizon in the given Latitude; and therefore the whole Time is $15^h 12'$.

Prob. L. *In a given Latitude, Day of the Year, and Hour of the Night, to find the ALTITUDE and AZIMUTH of a given STAR.*

Rectify the Globe to a given Latitude, and Day of the Year, then set the Hour Index to the given Hour, and move the Quadrant of Altitude to the given Star, its *Azimuth* will then appear in the Horizon, and its *Altitude* on the Edge of the Quadrant.

For Example: In the Latitude of *London*, the 11th of *May*, at XI o'Clock at Night, I find the Altitude of *Cor Leonis*, or *Lion's Heart*, to be $26^{\circ} 50'$, and its *Azimuth* $76^{\circ} 30'$ from the South towards the West, or nearly *West by South*.

Prob. LI. *From the observed Altitude of a Star, to find the Hour*

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Hour of the Night in a given Day of the Year, and in a known Latitude.

Rectify the Globe for the given Latitude and Day of the Year, then turn the Globe about in such a Manner that the Star may be upon the Edge of the Quadrant in the given Degree of Altitude, then will the Index point to the *Hour of the Night*. This is but the Converse of the former Problem, and therefore needs no Example.

Prob. LII. *From the observed HOUR and MINUTE of a STAR'S RISING, or SETTING on a given Day, to find the LATITUDE of the Place.*

Rectify the Globe to the given Day, and turn it about till the Index Points to the given Hour and Minute, where keeping it steady, let the Meridian be moved up and down in the Notches of the Horizon till the given Star touches the same, then will the Degrees of the Meridian, intersected by the North Part of the Horizon, shew the *Elevation of the Pole*, and consequently the *Latitude* of the Place.

For Example: Suppose, on the 11th of *May*, at IV in the Morning, I observe the bright Star in *Caput Medusæ* rising; then by rectifying and moving the Globe, as above directed, the *Latitude* of the Place will be found to be $24^{\circ} 30'$ North.

Prob. LIII. *From an Observation of two known Stars being upon the same Azimuth in a given Latitude, to find the HOUR of the Night.*

Rectify the Globe for the Latitude, and the Sun's Place on the given Day, then turn the Globe about in such a Manner, and also the Quadrant, till its Edge lies over both the given Stars precisely, then will the Index point to the *Hour of the Night*.

Thus, for Example: on the 11th of *May*, in the Latitude $51^{\circ} 30'$, the two Stars called *Lucida Lyræ*, and *Alcair*, will both be on the same Azimuth at $\frac{1}{4}$ past II in the Morning.

Prob. LIV. *From an Observation of two known STARS, having the same ALTITUDE, to find the HOUR of the NIGHT.*

Rectify the Globe to the given Latitude and Day of the Month, then move the Globe about so that the same Degree of the Quadrant may cut both the given Stars; then will the Index point to the *Hour of the Night*.

For Example: on the 11th of *May*, in Latitude $51^{\circ} 30'$, the bright Star in *Pegasus's* Wing, and that in the Head of *Andromeda*,

Andromeda, will both of them have an equal Altitude at Three Quarters of an Hour after II in the Morning.

N. B. This and the foregoing Problem are useful when the Quantity of the Azimuth, or the Altitude of the two Stars is not known: for, by a *Plumb-line only*, it may be known when any two Stars have the *same Azimuth*; and any Staff, &c. moved parallel to the Horizon, will give the *equal Altitude* of two known Stars with Ease.

Prob. LV. *From an Observation of a known Star in the Meridian, and another in the East, or West Part of the Horizon, to find the LATITUDE of the PLACE.*

Bring the Star that was observed in the Meridian of the Place to the Meridian of the Globe, and keep the Globe from moving round its Axis; then slide the Globe up and down in the Notches, till the other Star is brought to the East, or West Part of the Horizon, and that *Elevation of the Pole* will shew the *Latitude of the Place*.

Thus, for Example: When *Sirius* is upon the Meridian, *Arcturus* will be upon the Eastern Part of the Horizon in the Latitude of $44^{\circ} 40'$.

Prob. LVI. *From the observed Altitude of two Stars on a given Azimuth, to find the LATITUDE of the PLACE.*

Set the Quadrant over both Stars of the observed Degrees of Altitude, and there keep it from moving, then slide the Meridian up or down in the Notches 'till the Quadrant cuts the given Azimuth in the Horizon; then the Elevation of the Pole will be the Latitude required.

For Example: *Cor Hydræ*, and *Procyon*, or the little Dog Star, are both on the Azimuth of $78^{\circ} 45'$ South East, one with 5° of Altitude, and the other with 35° , in the Latitude of $26^{\circ} 30'$.

Prob. LVII. *To find the CIRCLE or Parallel of perpetual APPARITION, or OCCULATION of a fixed STAR in a given LATITUDE.*

By rectifying the Globe to the Latitude of the Place, and turning it round on its Axis, it will be immediately evident, that the *Circle of perpetual Apparition* is that Parallel of Declination which is equal to the Complement of the given Latitude Northward; and for the *perpetual Occulation*, it is the same parallel Southward; that is to say, in other Words, all those Stars whose Declinations exceed the Co-Latitude will always be visible, or above the Horizon; and all those

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48 *The Use of the CELESTIAL GLOBE*

in the opposite Hemisphere, whose Declination exceed the Co-Latitude, never rise above the Horizon.

For Instance : In the Latitude of *London* $51^{\circ} 30'$, whose Co-Latitude is $38^{\circ} 30'$, gives the Parallels desired ; for all those Stars which are within this Circle, toward the North Pole, never descend below our Horizon ; and all those Stars which are within the same Circle, about the South Pole, can never be seen in the Latitude of *London*, as they never ascend above its Horizon.

Prob. LVIII. *To represent the FACE of the HEAVENS on the GLOBE for a given HOUR on any DAY of the YEAR.*

Rectify the Globe to the given Latitude of the Place and Day of the Month, setting it due North and South by the Needle ; then turn the Globe on its Axis till the Index points to the given Hour of the NIGHT : Then all the upper Hemisphere of the Globe will represent the *visible Face* of the *Heavens* for that Time ; by which it will be easily seen what CONSTELLATIONS and STARS of Note are then above our Horizon, and what Position they have with respect to the Points of the Compass. In this Case, supposing the Eye was placed in the Center of the GLOBE, and Holes were pierced through the Centers of the STARS on its Surface, the Eye would perceive through the Holes the various corresponding STARS in the FIRMAMENT ; and hence it would be easy to know the several Constellations at Sight, and to be able to call all the Stars by their Names.

The Use of this Problem is most extensive, as it acquaints us at any Time with the apparent Face or State of the Heavens, and shews us when the MOON, or any of the PLANETS, may be seen, or fit for Observation by the Telescope. We can also from hence learn, when any of those curious and wonderful Objects, called *Nebulous STARS*, may be seen, and which strike the Mind of the Observer with Amazement, by presenting to his View an indefinite Number of the smallest fixed Stars *through the whole Field of View* in his Telescope.— From hence also, the Position of that very extraordinary Phænomenon called the *Galaxia*, or *Milky-way*, is at any Time known ; and from hence those silly and superstitious Notions of its having Relation to the Wind, with other *astrological Fooleries*, will intirely vanish.——This single Problem, therefore, may be considered in its self as sufficient to recommend the Use of the *Celestial GLOBE*, to every studious and rational Mind, as the most necessary Instrument
of

of his Celestial Tuition, or KNOWLEDGE of the HEAVENS.

By the following TABLE, the PLACES of the most considerable *Fixed STARS* are found upon the *Celestial GLOBE* in the same Manner as Places on the Surface of the *Terrestrial GLOBE* are found by a TABLE of their LATITUDE and LONGITUDE.

A TABLE of the Right ASCENSION and DECLINATION of the principal FIXED STARS.

The NAMES of the STARS, their Mark in Bayer, and their Magnitude.	Rt. Ascension			Declination.		
	D.	M.	S.	D.	M.	S.
<i>Algenib</i> in Pegasus. — — — γ 2.	0	11	17	13	49	56 N.
The Breast of Cassiopeia — — — α 3.	6	42	51	55	11	58 N.
The Tail of the Whale. — — — β 2.	7	50	45	19	19	23 S.
The Polar Star. — — — — α 2.	10	57	57	88	0	18 N.
The Girdle of Cassiopeia. — — — γ 3.	10	33	20	59	23	37 N.
The Girdle of Andromeda. — — — β 2.	14	0	49	34	19	31 N.
In the Ear of Aries. — — — — γ 4.	25	1	25	18	5	40 N.
The preceeding Horn of Aries. — — — β 3.	25	16	49	19	36	41 N.
The Foot of Andromeda. — — — γ 2.	27	16	15	41	9	5 N.
The bright Star of Aries. — — — α 2.	28	20	55	22	18	13 N.
The Wale's Mouth, <i>Mencar</i> . — — — α 2.	42	24	1	3	7	16 N.
<i>Medusa's Head</i> . — — — — β 2.	43	6	47	40	0	0 N.
The bright Star of Perseus. — — — α 2.	46	46	42	48	58	22 N.
The Bull's Eye, <i>Aldebaran</i> . — — — α 1.	65	30	3	16	0	1 N.
The Goat Star, <i>Capella</i> . — — — α 1.	74	41	38	45	43	14 N.
The Foot of Orion. — — — — β 1.	75	43	15	8	30	3 S.
The northern Horn of Aries. — — — β 2.	77	44	4	28	22	36 N.
The western Shoulder of Orion. — — — γ 2.	78	1	40	6	6	25 N.
The first of Orion's Girdle. — — — δ 2.	79	53	16	0	29	59 S.
The second. — — — — ϵ 2.	80	58	30	1	22	39 S.
The third. — — — — ζ 2.	82	7	52	2	5	30 S.
<i>Auriga's Shoulder</i> . — — — — β 2.	83	25	40	44	53	28 N.
<i>Orion's eastern Shoulder</i> . — — — α 1.	85	30	26	7	20	21 N.
Bright Star in the Foot of Gemini. — — — γ 2.	95	55	0	16	35	2 N.
The great Dog-Star, <i>Sirius</i> . — — — α 1.	98	36	42	15	23	57 S.
The northern Head of Gemini. — — — α 2.	109	45	49	32	23	48 N.
The little Dog-Star, <i>Procyon</i> . — — — α 2.	111	38	36	5	49	51 N.
The southern Head of Gemini. — — — β 2.	112	36	19	28	35	29 N.
<i>Hydra's Heart</i> . — — — — α 2.	138	54	50	7	36	58 S.
The Lion's Heart, <i>Regulus</i> . — — — α 1.	148	51	6	13	8	44 N.
In the great Bear. — — — — β 2.	161	45	0	57	40	38 N.
In the great Bear. — — — — α 2.	162	7	33	63	3	21 N.
The Tail of the Lion. — — — — β 2.	174	9	45	15	55	47 N.
In the Thigh of the Bear. — — — γ 2.	175	13	57	55	2	41 N.
In the great Bear, — — — — δ 3.	180	49	27	58	22	59 N.
The first Star in the Tail of the Bear. — — — ϵ 3.	190	48	48	57	16	57 N.
The Virgin's Wing. — — — — ϵ 3.	193	31	7	12	16	17 N.

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The NAMES of the STARS, their Mark in Bayer, and their Magnitude.	Rt. Ascension			Declination.		
	D.	M.	S.	D.	M.	S.
The Virgin's Spike. — — — — — α 1.	198	6	22	9	53	4 S.
The 2d Star in the Tail of the great Bear. ζ 2.	198	31	11	56	11	52 N.
The 3d Star in the great Bear's Tail. η 2.	204	29	11	50	31	58 N.
<i>Arcturus.</i> — — — — — α 1.	211	8	57	20	27	39 N.
The South Scale of <i>Libra.</i> — — — — — α 2.	219	22	8	15	0	58 S.
The first Shoulder of the Bear. — — — — — β 2.	222	55	5	75	8	53 N.
The north Scale of <i>Libra.</i> — — — — — β 2.	225	59	37	8	28	8 S.
The bright Star in the Crown. — — — — — α 2.	231	5	15	27	32	50 N.
The bright Star in the Serpent's Neck. α 2.	233	4	56	7	12	25 N.
The Northern Star in Scorpio's Forehead. β 2.	237	49	39	19	7	10 S.
The Heart of Scorpio. — — — — — α 1.	243	38	17	25	52	11 S.
The Knee of Serpentarius. — — — — — ζ 3.	245	57	5	10	3	13 S.
The Head of <i>Hercules.</i> — — — — — α 3.	255	51	37	14	41	10 N.
The Head of Serpentarius. — — — — — α 2.	260	54	57	12	45	25 N.
The bright Star in the Dragon's Head. β 3.	261	14	29	52	29	23 N.
The Serpent's Shoulder. — — — — — β 3.	262	52	7	4	41	23 N.
The bright Star in the Dragon's Head. γ 3.	267	45	55	51	31	32 N.
The southern Bow of Sagittarius. — — — — — ϵ 3.	272	0	40	34	28	13 S.
Bright Star of <i>Libra.</i> — — — — — α 1.	277	10	43	38	34	17 N.
The Shoulder of Sagittarius. — — — — — σ 3.	280	2	46	26	34	27 S.
The bright Star of <i>Aquila.</i> — — — — — α 2.	294	43	52	8	14	43 N.
The Horn of Capricorn. — — — — — β 2.	301	49	59	15	31	49 S.
Tail of the Swan. — — — — — α 2.	308	17	13	44	35	20 N.
The preceding Shoulder of Aquarius. β 3.	319	41	27	6	37	35 S.
Pegasus's Mouth. — — — — — ϵ 3.	323	3	31	8	46	21 N.
Star in the Tail of Capricorn. — — — — — δ 3.	323	23	58	17	12	56 S.
<i>Scheat</i> in Aquarius. — — — — — δ 3.	340	25	53	17	6	28 S.
<i>Fomalhaut.</i> — — — — — α 1.	341	2	23	30	54	12 S.
<i>Scheat</i> in Pegasus. — — — — — β 1.	343	0	18	26	46	7 N.
<i>Markab,</i> ditto. — — — — — α 1.	343	10	11	13	34	10 N.
Andromeda's Head. — — — — — α 2.	558	58	5	27	44	52 N.
Bright Star in Cassiope's Chair. — — — — — β 2.	350	5	0	57	48	27 N.

N. B. The Greek Letters α , β , γ , &c. are fixed to different Stars in each Constellation, for the Sake of a *more Particular and easy Nomination of them*; thus they concisely say, γ *Draconis* for one of the bright Stars in the Head of the Dragon Also the Digits 1, 2, 3, &c. after the Letters, denote the STARS of the *First, Second, Third, &c. MAGNITUDES*—In the last Column, the Letters N and S denote the DECLINATION to be *North or South*.

C H A P. VIII.

Of the various ASTERISMS and CATALOGUE of STARS, in the ZODIAC, and in the Northern and Southern HEMISPHERES.

THE Surface of the CELESTIAL GLOBE may be esteemed a just and adequate Representation of the *concave Expanse of the Heavens*, notwithstanding the Objections of *Shickardus* and others to its *Convexity*, for it is easy to conceive the Eye, placed in the Center of the Globe, and viewing the Stars on its Surface, supposing it made of Glass, as some of them are; or if *Holes* were made in the Center of each Star, then, as I said, the Eye in the Center of the Globe, would view through each of those Holes the *very Stars in the Heavens* represented by them.

Because it would be impossible to have any distinct or *regular Ideas or Notions* of the Stars in respect of their *Number, Magnitude, Order, Distances, &c.* without first reducing them to proper Classes, and arranging them in certain *Forms*, which therefore are called ASTERISMS or CONSTELLATIONS; this was done in the early Ages of the World by the first Observers of the Heavens, and those who made Spheres or Delineations; of whom Sir ISAAC NEWTON reckons *Chiron*, the fabled Centaur, the first who formed the Stars into Constellations, about the Time of the *Argonautic Expedition*, or soon after; and that the several Forms or *Asterisms* were, as it were, so many symbolical Histories, or Memorials of Persons and Things remarkable in that Affair. Thus *Aries*, the Ram, is commemorated for his *Golden Fleece*, and was made the first of the Signs, being the Ensign of the Ship in which *Phryxus* fled to *Colchis*. *Taurus*, the Bull, with brazen Hoofs, tamed by *Jason*; *Gemini*, the Twins, viz. *Castor* and *Pollux*, two of the *Argonauts*; the Ship *Argo*, and *Hydrus* the Dragon, &c. which all manifestly relate to the Affairs of that Expedition, which happened about forty or fifty Years after SOLOMON'S Death; or 34 Years before the Trojan War.

By this Means they could make Catalogues of the Stars, record their Places in the Heavens, and call them all by their Names. *Hipparchus* is said to be the first who framed a

Catalogue of the Stars, which was afterwards copied by *Ptolemy*, and adjusted to his own Time, *A. D.* 140. The Number in this was 1026, After this *Ulugh Beigh* made a Catalogue of 1022, reduced to the Year 1437. *Tycho Brahe* rectified the Places of 1000 Stars; but his Catalogue, published by *Longomontanus*, contains but 777, for the Year 1600. *Bayer* published a Catalogue of 1160. *Hevelius* composed a Catalogue of 1888 Stars, adjusted to the Year 1660. But the largest and most compleat of all, is the *British CATALOGUE* by Mr. *FLAMSTEED*, containing about 3000, of which scarce 1000 can be seen by the naked Eye in the clearest and darkest Night. They are rectified for the Year 1689. They are distinguished into seven Degrees of Magnitude in their proper Constellations; whose Names, together with the Number of Stars in each, and of each particular Magnitude, here follow, as I have taken them from the third Volume of the *Historia Cœlestis*.

The Constellations of the TWELVE SIGNS.

Names.	N ^o	Magnitude.						
		1	2	3	4	5	6	7
<i>Aries.</i>	65	0	1	2	5	6	28	23
<i>Taurus.</i>	135	1	1	4	13	21	44	51
<i>Gemini.</i>	79	1	2	4	6	12	32	22
<i>Cancer.</i>	71	0	0	0	6	7	39	19
<i>Leo.</i>	95	2	2	6	15	10	50	10
<i>Virgo.</i>	89	1	0	5	10	19	45	9
<i>Libra.</i>	49	1	2	7	5	11	21	2
<i>Scorpio.</i>	51	0	2	2	12	5	25	5
<i>Sagittarius.</i>	50	0	1	5	6	11	23	4
<i>Capricornus.</i>	51	0	0	3	3	9	34	2
<i>Aquarius.</i>	99	1	0	4	7	31	50	6
<i>Pisces.</i>	109	0	0	1	6	27	54	21

The Constellations of the NORTHERN HEMISPHERES.

<i>Andromeda</i> —	66	0	3	2	12	13	34	2neb.
<i>Aquila cum</i> }	70	1	0	10	7	15	32	5
<i>Antinoo</i> }								
<i>Anser cum Vulpe.</i>	34	0	0	0	4	12	18	0
<i>Auriga.</i> ———	68	1	2	1	10	18	31	5
<i>Bootes.</i> ———	55	1	0	8	10	11	17	8
<i>Cassiopeia.</i> ———	56	0	0	5	7	9	30	5
<i>Camelopardus.</i>	58	0	0	0	4	18	27	9
<i>Cepheus.</i> ———	35	0	0	3	7	8	14	3
<i>Coma Berenices.</i>	40	0	0	0	8	14	14	4
<i>Corona Septen.</i>	21	0	1	0	6	8	6	0
<i>Cygnus.</i> ———	107	0	1	6	21	31	48	0
<i>Delphinus.</i> ———	18	0	0	6	0	2	9	1
<i>Draco.</i> ———	49	0	1	7	8	13	19	1
<i>Equuleus.</i> ———	10	0	0	0	4	1	5	0
<i>Hercules</i> ———	95	0	0	11	15	31	38	0
<i>Leo Minor.</i> —	53	0	0	1	5	11	33	3
<i>Lacerta.</i> ———	16	0	0	0	3	6	7	0
<i>Lynx.</i> ———	44	0	0	0	3	12	21	8
<i>Lyra.</i> ———	21	1	0	2	2	5	11	0
<i>Perseus.</i> ———	67	0	2	5	11	15	28	6
<i>Pegasus.</i> ———	93	0	4	3	10	13	58	5
<i>Sagitta.</i> ———	23	0	0	0	4	1	18	0
<i>Serpens Ophiu-</i> }	59	0	1	7	6	3	32	10
<i>chi.</i> }								
<i>Scutum.</i> ———	7	0	0	0	2	4	1	0
<i>Serpentarius,</i> }	69	0	1	7	15	13	26	7
<i>or Ophiucus</i> }								
<i>Triangulum.</i> —	15	0	0	0	3	1	7	4
<i>Ursa Major.</i> —	215	0	6	6	35	58	91	20
<i>Ursa Minor.</i> —	24	0	0	4	3	5	6	6
<i>Canes Venatici.</i>	25	0	1	0	2	5	14	3

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The Constellations of the NORTHERN HEMISPHERE.

<i>Ara cum Thu- ribulo. — }</i>	9	0	0	1	6	2	0	0
<i>Argo, or Navis</i>	25	0	0	4	6	6	9	0
<i>Apus. —</i>	11	0	0	0	4	3	4	0
<i>Canis major. —</i>	32	1	7	1	4	11	5	3
<i>Canis minor. —</i>	15	1	0	1	0	3	9	1
<i>Cetus. —</i>	78	0	2	6	13	9	44	4
<i>Centaurus, — cum Lupo. }</i>	13	0	1	0	5	6	1	0
<i>Cameliontis. —</i>	10	0	0	0	0	9	1	0
<i>Calumba Noachi.</i>	10	0	2	0	1	6	1	0
<i>Corona Austr. —</i>	12	0	0	0	1	3	8	0
<i>Corvus. —</i>	10	0	0	3	2	2	3	0
<i>Crater. —</i>	11	0	0	0	8	2	2	0
<i>Eridanus. —</i>	68	0	0	12	15	20	20	1
<i>Grus. —</i>	3	0	0	0	2	1	0	0
<i>Hydrus. —</i>	10	0	0	4	2	3	1	0
<i>Lepus. —</i>	19	0	0	3	7	3	6	0
<i>Musca. —</i>	4	0	0	0	2	2	0	0
<i>Monosceros. —</i>	19	0	0	0	10	7	2	0
<i>Orion. —</i>	80	2	4	4	25	20	25	0
<i>Pavo. —</i>	14	0	1	3	5	4	1	0
<i>Phœnix. —</i>	13	0	1	5	0	1	0	0
<i>Piscis volans. —</i>	8	0	0	0	0	7	1	0
<i>Robur Carolinæ.</i>	12	0	1	2	7	2	0	0
<i>Sextans. —</i>	41	0	0	0	1	7	32	1
<i>Toucan. —</i>	9	0	0	4	2	3	0	0
<i>Triangulum. —</i>	5	0	1	2	0	2	0	0
<i>Xiphias. —</i>	6	0	0	1	2	1	2	0

7. In the Zodiac,
In the Northern Hemisph.
In the Southern Hemisph.
Sum of all the STARS.

Num	1	2	3	4	5	6	7
943	7	11	43	94	169	445	174
1511	4	23	93	227	356	695	113
547	4	20	56	136	145	176	10
3001	15	54	192	457	670	1316	297

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The Use of such a Catalogue of Stars is very great; for from hence we learn, (1.) If any *new Stars* at any time appear, which has never been observed before. (2.) If any Star, which *now appears*, shall in Time to come *disappear*. (3.) If the *new Star* which shall appear be the same with a Star that has *disappeared* formerly; and therefore, (4.) If the Stars have any *periodical Times of Apparition*. Hence (5.) The Means or Method of *predicting the Appearing or Disappearing of Stars*, (6.) By a Catalogue of the Stars we compare their respective *Places, Situations, and Distances*, with Ease. (7.) By this Means we also compare and determine the true Places and Motions of the heavenly Bodies in general and of the *Sun, Moon, Planets, and Comets* in particular, with many other useful Purposes.

Now it is actually Fact, that some *new Stars* appear, and that others *disappear*; yea, that they *change* their *apparent Magnitude* and *disappear by Degrees*. *Hipparchus* the first of Men observed a *new Star*, (120 Years before *Christ*) which occasioned his making a Catalogue of the Stars. Another is said to have appeared *A. D.* 130; another *A. D.* 389; one exceeding bright in the 9th Century, and another in the Year 1264.

But the first *new Star*, of which we have any good Account, is that in the Chair of *Cassiopeia*, first observed by *Cornelius Gemma*, on the 9th November 1572, and by *Tycho Brahe* on the 18th. Sir ISAAC NEWTON says it equalled *Venus* in Brightness at its first Appearance, and gradually declined in its Lustre, till it totally disappeared in the *March* following. This Star is supposed to be the same that appeared in the Years 945 and 1264, having its Period about 310 or 320 Years.

In Aug. 13, 1596, D. *Fabricius* observed another *new Star* in the *Neck of the Whale*; and through the 17th Century this Star was observed to *appear and disappear periodically*, its *Period* being equal to 333 Days. The *Phænomena* of this, and the like Stars, are supposed to be owing to the Spots on their Surface, which sometimes increase and sometimes decrease, in the manner as we have observed they do on the Surface of our Sun; for at some Times the *Solar Spots* are so large as to be visible to the *Naked Eye*, and very numerous at the same time? at other Times, no Spot at all has appeared on the Sun for two or three Years together.

The different apparent *Magnitudes* of the Stars are owing to

to their *different Distances* from us. Had we *Telescopic Eyes*, we should see many more. *Seventy Stars*, and more, have been discovered in the *Pleiades*, commonly called the *Seven Stars*; and all that Tract of the Heavens called the *Milky Way* (or *Galaxy*) is well known to be owing to the Refulgence of a prodigious Multitude of Stars disseminated through those Parts of the Universe, though at so great a Distance as to be invisible to the naked Eye; yet are they discernable in great Numbers through a Telescope, and more in Proportion as the Instrument is better. But for the almost infinite (at least, inconceivable and immense) Distance of the nearest fixed Star, the Reader may see a Calculation in MARTIN's *Philosoph. Britan.* Vol. 3. P. 263, Edit. 3d.

Hence likewise we account for that particular Phænomenon we call a *nebulous Star*, or cloudy faintish light Spots, that appear like Stars in an indirect View; for in order to this you have no more to do than to direct a good Telescope to any one of them, and you will be agreeably surprized with a View of a *great Multitude of very small Stars*, which were the Cause of the *luminous Spot* to the naked Eye.

To the very small apparent Magnitude of the Stars we owe their constant *Twinkling*; for being but lucid Points, every *opaque Corpuscle* or *Atom* floating in the Air, will be big enough to cover and *eclipse* them, when they get in the Right Line connecting the Star and the Eye; which *Alternations of momentary Occulations and Apparitions* make the *Twinkling* of the Stars we now speak of.

THE

THE USE OF THE TERRESTRIAL GLOBE.

C H A P. I.

*The SOLUTION of Geographical PROBLEMS by the
Terrestrial GLOBE.*

Prob. I.

*To find any particular PLACE on the Globe, from a Table of
given LATITUDES and LONGITUDES.*

Bring the Degree and Minute of *Longitude* to the General Meridian, and look for the given *Latitude*, whether North or South, on the said Meridian, and just under it will be the Place required. For Example, let it be required to find LONDON, whose Longitude is 0, and Latitude $51^{\circ} 31'$; then supposing the first Meridian of Longitude, in the Table, to pass through *London**, and using a Globe of 12 Inches Diameter, bring the Beginning or 0° of Longitude, (which you will find on the under Side of the Equator,) to the Meridian, and exactly under $51^{\circ} 30'$ on the Meridian, you will see the City of *London* on the Globe.

Again: Suppose, in the Table, you find the Longitude of *Constantinople* to be $28^{\circ} 55'$, and the Latitude $41^{\circ} 0'$; then, bring $28^{\circ} 55'$ of the Equator to the Meridian, and under $41^{\circ} 6'$ on the North Part of the Meridian, you will observe the City of *Constantinople* on the Globe.

Prob. II. *To find the LATITUDE and LONGITUDE of any Place observed on the Surface of the Globe.*

Let the given Place be *Constantinople*, then, turning the Globe about, bring that City to lie under the Graduated Meridian, and you will observe the Degree just over it to be $41^{\circ} 2' N.$ Latitude: Then, without moving the Globe, ob-
I serve

* The Table of Latitude, &c. inserted at Page 72, is taken from the Requisite Tables, second Edit. lately published by Order of the Board of Longitude, where the first Meridian passes through Greenwich.

serve the Degree on the under Side of the Equator cut by the Meridian, and you will find it to be $28^{\circ} 54'$ E. Again: Let the given Place be *Port Royal* in *Jamaica*, which bring to the Meridian, and you will find it to lie under the 18° of North Latitude, and 77° of West Longitude.

N. B. By this Problem the *Difference of Latitude* and *Difference of Longitude* between any two Places are given. Thus the *Difference of Latitude* between *London* and *Constantinople* is $10^{\circ} 24'$, and the *Difference of Longitude* between *Constantinople* and *Port Royal* in *Jamaica* is found to be $105^{\circ} 55'$

Prob. III. *To find all the PLACES of the same LATITUDE and LONGITUDE with those of any given PLACE.*

Bring the given Place to the Meridian, then all those Places which lie under the Meridian have the *same Longitude* with the given Place; and, turning the Globe on its Axis, you will observe all those Places which pass under the same Degree of the Meridian with the given Place, will have the *same Latitude* with it.

Prob. IV. *To find the DISTANCE between any two Places on the Globe in English MILES.*

Bring one of those Places to the Meridian, then, if the other Place lies under the Meridian also, the Distance between them will easily appear in Degrees of the Meridian; but if the other Place is not under the Meridian, fix a Quadrant of Altitude over one Place upon the Meridian, and then bring it to lie over the other given Place, and the Difference between them, in Degrees of a great Circle, will be shewn on the Edge of the Quadrant, which, multiplied by the Number $69\frac{1}{2}$, (the MILES in one Degree) will give the Distance in *English Miles*: Thus the Distance between *London* and *Rome* will be found to be about 13° , which reduced, will give $903\frac{1}{2}$ *English Miles*, or 780 *Geographical Miles*, reckoning 60 to a Degree.

Prob. V. *To find all those PLACES that are at the same DISTANCE from any given Place, as LONDON, for Instance.*

Bring the given Place, or *London*, to the Meridian, and fix the Quadrant of Altitude precisely over it, then turning the Quadrant about upon the Surface of the Globe, you will observe all those Places over which the same, or a given Degree of the Quadrant, passes, and they will be *all equidistant* from *London*; for, by this Means, the *Parallels of equal Distance* will be described from the *Zenith* to the *Horizon*.

Prob.

Prob. VI. *To find the ANGLE of POSITION, or the BEARING of any one Place from another given, as London.*

Rectify the Globe for the Latitude and Zenith of one of the given Places, *viz. London*, and fix the Quadrant of Altitude over it; then bring the said Quadrant to lie over the other given Place, and it will shew, in the Horizon, the *Point* of the COMPASS on which it bears from *London*; and the Angle, which is contained between the Quadrant of Altitude and the Meridian, is called the *Angle of Position*: Thus let the two given Places be *London* and *Port Royal* in *Jamaica*; then, by rectifying the Globe for the City of *London*, let the Quadrant of Altitude (fixed over *London*) be laid upon *Port Royal*, and it will cut the Horizon in the *Western Point* very nearly; and thereby shews that *Port Royal* bears almost WEST from *LONDON*.

But if the Globe be rectified for *Port Royal*, and the Quadrant of Altitude be laid over the City of *London*, it will cut the Horizon in about $40^{\circ} 30'$ from the North Point *Eastward*, which shews that *London* bears nearly *North-east* from *Port Royal*, or the Angle of Position is $40^{\circ} 30'$ from the North towards the East.

Hence it appears, that the *geographical Bearing* of Places is very different from a *Bearing* taken in a *Nautical Sense*; for, with Navigators, if one Place A bears *West* from another Place B, the Place B will bear *East* from the Place A, because they estimate the Bearing in a *Rhumb Line*, but the Geographers in the Arch of a *Great Circle*.

And again, if one Place A bears *North-East* from another Place B, the same Place B will bear *South-West* from the Place A, as being both on the same RHUMB, or Artificial Curve, which cuts every Meridian under the same Angle; but neither of those Cases can be true in a *Geographical Sense*, as appears from the two Places of *London* and *Port Royal* in the above Problem.

Prob. VII. *When it is NOON in a given Place to find what Hour of the Day it is at any other Place proposed.*

Bring the given Place to the Meridian, and set the Hour Index to the XII, then turn the Globe about till the Place proposed comes to the Meridian, and the Index will point to the Hour required.

Let the Example be for *London* and *Pekin* in *China*: Then placing *London* under the Meridian, and the Index to XII, you revolve the Globe and bring the City of *Pekin* to the Meridian,

Meridian, when the Index will point to 40' after VII in the *Evening* for the *Hour there*, when it is *Noon* with us.

But if the Place proposed has West Longitude from *London*, as *Jamaica*, for Instance: Then turn the Globe Eastward 'till *Port Royal* comes under the Meridian, and the Index will point to about 45' after VI in the *Morning*, the *Hour* of the *Day* with them, when *Noon* with us.

Prob. VIII. *To find all those PLACES where it is NOON at any given Hour of the Day, at a given PLACE.*

Bring the given Place to the Meridian, set the Index to the given *Hour*, then turn the Globe about till the said Index points to the XII: Then observe *all those Places* which lie under the brass *Meridian*, for to them it is *Noon at that Time*.

For Example: Let *London* be the given Place; and let it be required to find all those Places where it is *Noon* when it is $\frac{1}{2}$ an Hour after VII in the *Morning* at *London*: Then proceeding as above directed, you will find the brass Meridian lie over *Muscovy* in *Asia*, and Part of the Mogul's Empire, in all which Places it is *Noon* at that Time. By the same Method it will be found, that when it is IV o'Clock in the *Afternoon* with us, it will be *Noon* at *Martinico*, *Antigua*, and other of the Windward Islands; also at *Louifbourg* in *North America*, and over all the Middle Part of *South America*.

Prob. IX. *For any GIVEN HOUR of the Day in the Place where you are to find the HOUR of the Day in any other PLACE proposed.*

Bring the Place where you are to the Meridian, and set the Index to the given *Hour*, then turn the Globe 'till the Place proposed comes to the Meridian, and the Index will shew the *Hour of the Day there*, as required.

Thus, for Example: when it is IV o'Clock in the *Afternoon* with us, it is $\frac{3}{4}$ after XI at Night at the City of *Pekin* in *China*.

Prob. X. *For any GIVEN HOUR at a given PLACE, to find all those PLACES where it is any other given HOUR of the Day.*

Bring the given Place to the Meridian, and set the Index to the given *Hour*, then revolve the Globe till the Index points to the other given *Hour*: Then all those Places which lie under the Meridian have that *Hour of the Day*. *This Problem is so plain as to need no Example.*

Prob.

Prob. XI. *To find all those Places to which the Sun is VERTICAL for any given Day.*

Bring the *Sun's Place* for the given Day to the Meridian, and observe the *Degree of its Declination*: Then turn the Globe quite round, and all those Places that pass under the same Degree of the Meridian are those required, or to whom the Sun will be vertical for that Day.

Thus, for Example: On the 10th of May, when the Sun's Declination is $17^{\circ} 30'$, all those People who live under that Parallel of North Latitude have the Sun in their Zenith that Day at Noon: Amongst these you will find the Inhabitants of *Porto Rico*, *Hispaniola*, *Jamaica*, &c. in the Western Hemisphere; the Midland Parts of *Africa*, the Southern Part of the *Mogul's Empire*, and the Kingdom of *Pegu* in the farther *India*.

Prob. XII. *To find what DAY of the Year the SUN will be vertical in the torrid Zone to any given PLACE.*

Bring the given Place to the Meridian, and mark the Degree exactly over it; then turn the Globe round and observe the two Points of the *Ecliptic* which pass under that Degree of the Meridian: Lastly, see on the Wooden Horizon on what Day of the Year the Sun is in those Points of the *Ecliptic*, for those are the Days required.

For Example: Let the given Place be *Jamaica*, which bring to the Meridian, and observe the Degree under which it lies; then, revolving the Globe, the two Points of the *Ecliptic* which pass under the same Degree of the Meridian will be the 20° of *Taurus*, and 10° of *Leo*, and therefore the two Days in which the Sun possesses those two Degrees of the *Ecliptic* will be the 9th of *May* and the 2d of *August*, which will be the two *Mid-summer Days* to the People of that Island.

Prob. XIII. *To find those PLACES in the North Frigid ZONE where the Sun begins to shine constantly, without setting, on any given Day between the vernal EQUINOX and MID-SUMMER.*

Find the Sun's Place in the *Ecliptic* for the given Day; bring it to the general Meridian, and observe the Degrees of Declination; then all those Places which are the same Number of Degrees distant from the Poles, are the Places required to be found.

Thus, for Example: On the 10th of *May* the Sun's Declination is $17^{\circ} 30'$, which deducted from 90° , the Remainder

ⁱs $72^{\circ} 30'$: Therefore all those Places whose Latitude is equal to $72^{\circ} 30'$ will have the Sun in the Northern Part of the Horizon at XII o'Clock at Night.—The Reason of all which is evident by a bare Inspection of the Globe. When made use of as a Tellurian, with the Brass Cemi-circle of Illumination or new Solar Horizon.

Prob. XIV. *To find on what DAY the SUN begins to shine constantly, without setting, in any given Place in the North Frigid Zone, and how long.*

Rectify the Globe to the Latitude of the Place, and, turning it about, observe what Points of the Ecliptic between *Aries* and *Cancer* cut the North Point of the Horizon; then find, by the Calendar, (on the Horizon,) what Days the Sun will enter those Degrees of the Ecliptic, and they will satisfy the Problem.

Thus, for Example: Rectify the Globe for the Midland Parts of *Nova Zembla*, whose Latitude is 75° , and then turning the Globe about its Axis, you will see the 15° of *Taurus* and the same Degree of *Leo* both touch the North Point of the Horizon; therefore, on the 4th of *May* the Sun begins to shine without setting, and so continues till the 8th of *August* following:—At the same Time it appears, that in this very Place, when the Sun has more than 15° of South Declination, it ceases to rise above their Horizon, in the *Winter Half of their Year*, and continues just as long invisible. This is seen by Inspection, by using the Globe with the Solar Horizon rectified to the Sun's Declination from the Pole.

Prob. XV. *To find the PLACE, or Part of the SURFACE of the Terraqueous GLOBE, over which the Sun is vertical on any given DAY, HOUR, and MINUTE.*

Find the Sun's Place and Declination for the given Moment of Time; then find (by Prob. IX.) those Places which have the Sun on the Meridian at that Time; and, among them, that which lies under the given Degree of Declination is the Place desired, or that in whose Zenith the Sun then is.

Thus, for Example: On the 10th of *May* at VIII o'Clock in the Morning, admit the Sun's Declination be $17^{\circ} 30'$, then proceeding as above directed, we shall find it to be Noon in all those Places from the Middle of *Nova Zembla* to the Middle of the Southern Part of the *Persian Empire*, and, amongst them, that Part which is exactly under the Degree of the Sun's Declination is a Point of the *Arabian Sea*, over which the Sun is vertical at the given Time.

Prob.

Prob. XVI. *To find, for any given DAY and Hour, those PLACES wherein the Sun is then rising or setting, or on the Meridian; also those Places which are enlightened, and those which are not.*

Find the Place to which the Sun is vertical at the Time given, and bring the same to the Meridian, and elevate the Pole to the Latitude of the said Place, then all those said Places which are in the *Western Semi-circle* of the Horizon have the *Sun rising*; and those in the *Eastern Semi-circle* see it *setting*: And to those *under the Meridian* it is *Noon*. Lastly, all Places above the Horizon are enlightened, and all below are in *Darkness*, or *Night*.

Thus, for Example: Let the Place be that Part of the *Arabian-Sea* which was found in the last Problem, to which the Sun is *vertical* on the 10th of *May* at VIII in the Morning, and having rectified the Globe for that Place, (which is always equal to the Sun's Declination,) bring the said Place to the Meridian, and there let the Globe rest: Then it is evident, that all those Places that lie *under the Meridian* have their *Noon Day*: Then all those Parts of the Earth, lying under the *Western Semi-circle* of the Horizon, will see the *Sun rising*, as they are all of them at 90° distance from it; and the Motion of the Globe carrying them towards the Sun, he will appear to *rise gradually* above their Horizon.— On the contrary, those Parts of the Globe under the *Eastern Semi-circle* of the Horizon, being also every where 90° distant from the Sun, will see him *setting*, being carried by the Motion of the Globe out of the enlightened into the *dark*, or *neither Hemisphere*. The above is also solved by the Globe as a Tellurian.

Prob. XVII. *The Day and Hour of an ECLIPSE of the SUN or MOON, or TRANSIT of the PLANETS or other Phænomenon in the Heavens being given, to find all those Places on the Surface of the Globe, where the Beginning, Middle, or End thereof will be visible.*

Find the Place to which the Sun is vertical at the given Instant, for the *Beginning*, *Middle*, or *End* of the TRANSIT or ECLIPSE: Then will those Phases be visible at all those Places which are above the Horizon at those Instants of Time.

Prob. XVIII. *To find in what LATITUDE the longest DAY is of a given Length*

Bring

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Bring the *solstitial Points* to the Meridian, and set the Index to XII at Noon, then turn the Globe Westward 'till the Index points at *Half the Number of Hours* given, which being done keep the Globe from turning round its Axis, and slide the Meridian up or down in the Notches 'till the *solstitial Point* comes to the Horizon: Then that *Elevation of the Pole* will be the *Latitude* required.

For Example: Suppose the *Latitude* be required in which the Day is 14 Hours; by proceeding as above directed, the *Latitude* will be found near the *Parallel* of 40° , and for the *longest Day* of 20 Hours the *Latitude* will be something more than 63° .

Prob. XIX. *To exhibit a general Representation of the Lengths of DAYS and NIGHTS throughout the YEAR, in any given Latitude.*

Elevate the Globe to the *given Latitude*, and bring the *Solstice* to the Meridian, where let it rest: Then will the *Parallels of North Latitude*, from the Equator to the *Tropic of Cancer*, represent the diurnal Arches, or Length of Days in the Summer Half Year, from the *Mean Day* when the Sun is in the Equator, to the *longest Day*, which is represented by the *Tropic itself*. Then, for the *Winter Half Year*, the same *Parallels of South Latitude* above the Horizon do represent the *decreasing Length of Days*, from the *Mean Day* in the Equator, to the *shortest* in the *Tropic of Capricorn*.—Indeed nothing can be more amusing or instructive, than to shew how instantaneously, by the Globe, *all the Variety of different LENGTHS of DAYS and NIGHTS*, for *every Part* of the YEAR, and for *every Latitude* of Place, are represented to the View by a Motion of the Meridian up and down in the Notches of the Horizon:—It gives us a transient, and, as it were, simultaneous View of all the *Phænomena* and *VICISSITUDES* of all the SEASONS in the *whole Year*, and throughout the WORLD, at once, and in every *different Position* of the GLOBE.*

Prob. XX. *To find those INHABITANTS of the Earth called the PERIOECI with respect to LONDON.*

Bring

* This Problem is also illustrated in a more elegant manner if the Globe is made use of (as a Tellurian) with a Semi-circle of Illumination, or Solar Horizon. See a fuller Account in the Improvement made by G. WRIGHT.

Bring *London* to the Meridian and set the Hour Index opposite XII; then turn the Globe about till the Index points to the XII, and the Part of the Globe under $51^{\circ} 30'$ of the upper Meridian, is that required, which, being the Northern Part of the great *Pacific Ocean*, it appears there are no Inhabitants of that Denomination with Respect to *London*; but the greatest Part of *China* in *Asia*, and the *Gulph of Mexico* in *America*, or what is usually called the *West-Indies* are very nearly *Periæci*, to each other.

Prob. XXI. To find those INHABITANTS of the Earth that are called ANTOECI.

These are found by counting equal Degrees of Latitude from the Equator upon the Meridian on either Side.

Thus, for Example: *Tripoli*, on the Northern Coast of *Africa*, and the *Cape of Good Hope*, on the Southern Point, lie nearly in the same Parallel of Latitude, and under the same Meridian, are *Antæci* to each other, having the same Length of Days and Nights, and the same *Vicissitudes of Seasons*; but at opposite Times of the Year.

Prob. XXII. To find the ANTIPODES to any given Place, as LONDON, for Instance.

Bring *London* to the upper or diurnal Semi-circle of the Meridian, then, in the nether Semi-circle of the Meridian, reckon the same Number of Degrees Southward from the Equator as is equal to the North Latitude of *London*, viz. $51^{\circ} 30'$; the Point of the Globe lying under this Degree of the lower Meridian, is that diametrically opposite to *London*, and therefore they are *Antipodes* to each other: This appears to be a Part of the Southern OCEAN, near *New-Zeland*: thus the Midland Parts of *Tartary* and Southern Parts of *America*, called *Terra Magellanica*, are *Antipodes* to each other, as is easily seen by the Globe.

Prob. XXIII. To find those PLACES in the Torrid Zone, to whom the Sun will appear twice in the Forenoon or Afternoon upon the same AZIMUTH.

Let the Sun be in the Beginning of *Cancer* on the longest Day, and then there are many Latitudes in the Torrid Zone in which this Phænomenon may be observed. Thus if we take the Latitude of *Jamaica* 18° , and rectify the Globe thereto, the Quadrant of Altitude will, in one certain Azimuth, touch the Parallel or Tropic of *Cancer*; but if removed a little more Southward, it will cut the said Parallel in two Points, and continue to do so till it coincides with the said Parallel in the Horizon: Therefore bring the Beginning of *Cancer* to the

Meridian, and set the Hour-Index to XII, then turn the Globe about till the Beginning of *Cancer* be in the *Eastern Horizon*, and the Hour-Index will point to $\frac{1}{2}$ after V, which is the Time of Sun-rising in that Latitude on their *longest Day*.—Again, place the Quadrant of Altitude to the same Point of the Horizon, where the *Ortive Amplitude* is 25° , and then will the Quadrant be the *Azimuth* in which the Sun rises for that Morning; and as the Sun advances, it will gain *Azimuths* more and more Southward, till about IX o'Clock, and afterward return over them to the North, where it will be at XII.

Thus, for Example: At VII o'Clock it will be nearly upon the Azimuth of 70° from the North at VIII o'Clock it will be on the Azimuth of 72° , and about $45'$ after VIII it will attain its *most Southern Azimuth*, which is about 73° , at the *Altitude* of about 45° above the Horizon: On this Azimuth it will appear for *some Time*, viz. till about IX o'Clock, and at the Altitude of 50° it will begin to go off upon *Azimuths* more and more Northern. Thus at X o'Clock it will be again upon the Azimuth of 72° from the North; at $\frac{1}{2}$ after X it will be again upon the Azimuth of 60° ; at $50'$ after X it will again get upon the *Azimuth equal to the Amplitude*, and then proceed through all less Degrees of Azimuths to the North.

N. B. In this Method of solving this very curious Problem, the *Rationale* of this odd Phænomenon will more plainly appear, as also the Reason why it can be seen only by the *Inhabitants* of the *Torrid Zone*; and most evidently to those between 15 and 20° of Latitude.—It may be farther observed, that this very Problem is a remarkable Case of the *Ambiguity* of *spherical Triangles*, since, in a given Latitude, Declination, and Azimuth of the SUN, if the Hour of the Day be required, it is very evident from hence there may be two Answers given, and it will be uncertain which is the right, unless from some particular Conditions of the Problem.

Prob. XXIV. To find all those Places of the Earth where an ECLIPSE of JUPITER'S SATELLITES will be visible.

We have already shewn when *Jupiter* may be seen in any particular Place, or Latitude; but it may be necessary, on many Accounts, to give a more general Solution to this Problem, and to shew how, by the Globe, it will be easy to know all those Places of the Earth's Surface where Eclipses of *Jupiter's* Moons may be observed at any Time of the Year,

Year, which will be very useful to *Navigators, Astronomers, &c.*

If *Jupiter* be in *Consequentia*, or follows the Sun, and sets after him in the Evening, then proceed thus: Find that Part of the Earth's Surface to which the Sun is vertical, (by Prob. XV.) and rectifying the Globe to the Sun's Declination, bring that Place to the Meridian which will then be in the Zenith, and place the Hour-Hand to XII; holding the Globe fast in this Position, with a *Black-lead Pencil* or *Chalk*, draw a Line on the Surface of the Globe, along the *Eastern Semi-circle* of the Horizon, and that will denote all those Places to whose Inhabitants the Sun is *setting at that Time*, as we have shewn in the fore-mentioned Problem.

Then find the Difference of the *Sun's Right Ascension*, and that of *Jupiter*, in TIME; and turn the Globe *Westward*, till the Index points to that Difference; and then rectifying the Globe to the *Declination* of *Jupiter*, hold it fast, and draw another *Semi-circle* on the Globe by the *Eastern Side* of the Horizon: Then the Space between these two *Semi-circles* will include all those Places on the Earth's Surface, where *Jupiter* will be seen *after Sun-set*.

In the same Manner, if *Jupiter* be in *Antecedentia*, or rises before the Sun, you proceed as before for the Place to which the Sun is vertical, and having brought it to the Meridian and fixed the Index to XII, you draw a Line by the *Western Edge* of the Horizon, to shew the Places where the *Sun is Rising*; then Rectify the Globe for *Jupiter's Declination*; and turning it *Eastward* till the Index points to the Difference of the *Right Ascension* of the Sun and *Jupiter*, and there holding it fast, draw another Line by the *West Side* of the Horizon; and the Places between this and the former *Semi-circle*, are those to whom *Jupiter* will be *visible before Sun-Rising*.

Prob. XXV. To make an Horizontal Dial. Elevate the Pole equal to the Latitude of the Place, then will the Axis of the Globe represent the Gnomon or Style of the Dial: Conceive in your Mind the Paper on which the Dial is to be delineated, to be on the Horizon of the Globe.

Bring any Meridian to lie exactly under the General Meridian; then as the Meridians are drawn at every 15° of the Equator, they will represent Hour Circles, and therefore we have only to observe how many Degrees these Meridians, or

Hour Circles, intersect the Horizon from the General Meridian, or 12 o'Clock Hour Circle?

Thus for Example, in Latitude $51^{\circ} \frac{1}{2}$, which is the Latitude of London, their Distances from the Meridian are as in the annexed Table.

<i>Hours.</i>		<i>Dist. from Merid.</i>	
<i>Morning</i>	<i>Evening.</i>	<i>d</i>	
XI.	I.	11.	51
X.	II.	24.	19
IX.	III.	38.	3
VIII.	IIII.	53.	36
VII.	V.	71.	6
VI.	VI.	90.	0

Then to construct the Dial, which may be of any Figure, round, square, or multangular.

For Example, suppose a Square, as in Pl. 2d, Fig. 6, draw a Line VI, VI, to represent the East and West, or VI o'Clock Line; and perpendicular to it A, XII; for the Meridian or 12 o'Clock Line.

About A as a Center, with a Pair of Compasses extended to 60° on a Line of Chords, describe the Semi-circle bcd , on which from c on each Side towards b and d set off the Degrees in the above Table, then Lines being drawn from A through these Points, and produced to the Sides of the Dial, will be the Hour Lines required. As for the Morning Hours before, and the Evening ones after VI, they are drawn by only producing the others upwards.

As the Elevation of the Pole above the Horizon is equal to the Latitude of the Place, make the Angle cAe equal to $51^{\circ} \frac{1}{2}$ for London (or Bristol) then will cAe represent the Gnomon, which make in Brass, and fix upright on the Meridian Ae , so that the Point A of the Gnomon corresponds to the Point A of the Dial.

Lastly, lay this Dial on an Horizontal Plane, where a Meridian or North and South Line is drawn, so that $aXII$ may coincide with that Line, then will the Shadow of the Gnomon, caused by the Light of the Sun, shew the true apparent Time of the Day.

I might

I might now proceed to the Construction of various other Dials, but as it is not my Intention, at present, to treat of Dialling in general, I shall only observe, that a Dial may be conceived to be drawn on any other Plane, either vertical or inclined, in any Angle to the Horizon; by only conceiving the Plane on which the Dial is to be drawn to pass through the Globe in that Position; then will the Interfection of the Hour Lines (or Meridians each 15° asunder) cut on the Dial Plane, the Places where the Hour Lines are to be drawn:— And the Elevation of the Pole above that Place, will represent the Height of the Stile or Gnomon.

C H A P. II.

The USE of the ANALEMMA on the Terrestrial GLOBE.

THE *Analemma* is a small SLIP of PAPER, now first engraved on the Surface of the New Terrestrial Globes; the Length of it is just equal to the Breadth of the Torrid Zone, or Distance between the two Tropics. It contains the CALENDAR of Months and Days in two Parts, beginning from the Day of the Winter Solstice, and proceeding to that of the Summer Solstice on one Part, and from thence it returns again to the Winter Solstice. The Months and Days are so laid down and divided as to correspond exactly with the Declinations North or South, which the Sun has on each respective Day through the Year.—This will evidently appear if the said *Analemma* be brought to lie under the General Meridian, and from thence the following Problems may easily be deduced.

Prob. XXVI. *To find the SUN'S DECLINATION on any Day of the Year, by the ANALEMMA, without knowing its Place.*

Bring the *Analemma* to the Meridian, and thereon, over the given Day of the Month, the Sun's Declination may be seen.

Prob. XXVII. *To find by the ANALEMMA the SUN'S PLACE in the Ecliptic and RIGHT ASCENSION, for any given Day of the Year.*

Bring the *Analemma* to the Meridian, and hold a Pin or Wire against it over the given Day; then turn the Globe about 'till a Point of the Ecliptic comes under the Wire, which

which will shew the *Sun's Place* in that Quarter of the Ecliptic which corresponds to the Quarter of the Calendar, in which the given Day is. Its *right Ascension* is shewn in the Equinoctial Line, at the same Time.

Prob. XXVIII. *To find by the ANALEMMA the Time of the SUN's RISING and SETTING, with its AMPLITUDE, for every Day in the Year by Inspection, in a given LATITUDE.*

Rectify the Globe for the given Latitude of the Place, and bringing the middle Part of the *Analemma* to the Meridian, set the Hour-Index to XII, then turn the Globe about to the East 'till the *most Southern Part* of the *Analemma* coincides with the Horizon, then will the Index point to about $\frac{1}{2}$ after VIII in the Morning for the Time of *Sun rising* on the *shortest Day*.—Then bring any other Day between the 20th of *January* and the 20th of *March*, to the Horizon, and the Index will shew the Time of the Sun's rising for that Day.—Also from the 20th of *March* to the 20th of *June*, any given Day of the ANALEMMA being brought to the Horizon, the Index will shew the Time of its rising on that Day also;—Consequently, the Time of the *Sun-rising* and *Sun-setting*, from one End of the six Months to the other, is seen for every Day respectively, by the *Analemma* through the various Parts of the Horizon; and its *Amplitude* for every Day is shewn by Inspection, from 38° of *South Amplitude* to 38° of *North*.—And all that has been said about its *rising* is the same with regard to its *setting*. By this Means a general Idea may be formed, as it were, instantaneously, of the various *Lengths of Days and Nights* throughout the Year..

Prob. XXXI. *To find, by the ANAMELLA, the Sun's ALTITUDE and AZIMUTH, for any given DAY and HOUR.*

Rectify the Globe for the Latitude and for the *Analemma*, then turn the Globe 'till the Index points to the given Hour, and bring the *Quadrant of Altitude* to lie over the given Day of the Month, and that Day will shew, on the Edge of the Quadrant, the *Altitude* of the Sun; and, in the Horizon, the *Azimuth* is shewn (by the QUADRANT) from the South, or North Points.

For Example: On the 10th of *April* at IX in the Morning, the *Sun's Altitude* is found about 33° , and its *Azimuth* 56° from the South.

Prob. XXX. *At a given Hour in the Morning, or Afternoon, to find all the different ALTITUDES and AZIMUTHS the SUN can have for every DAY in the YEAR.*

Rectify

Rectify the Globe to the Latitude and *Analemma*, then revolve the Globe till the Index points to the given Hour, and there keep it steady; then bring the Quadrant of Altitude to lie over the Southern Part of the *Analemma*, and it will shew the Sun's *Altitude* and *Azimuth* on the *shortest Day* of the Year at that given Hour: Then removing the Quadrant of Altitude gradually over all the Length of the *Analemma* till it comes upon the *most Northern Part*, and there the *greatest Altitude* and *Azimuth* will appear on the Edge of the Quadrant in the *Analemma* and Horizon.

For Example: Let the Hour given be IX in the morning, then will the Altitude on the *shortest Day* be 49° only, and the Azimuth 44° ; and on the *longest Day* the Altitude will be 43° , and the Azimuth, 73° , so that the *Altitude* will vary at that Hour no less than 39° and the *Azimuth* 29° .

Prob. XXXI. To find all the different Times of the DAY, throughout the YEAR, on which the SUN will be upon a given AZIMUTH, and its ALTITUDE for those Times, on every DAY respectively.

Let the given Azimuth be that of 45° or South East, and the Globe being rectified for the Latitude and *Analemma*, bring the Quadrant of Altitude to the given Azimuth; then move the Globe about till the Southern Part of the *Analemma* comes to the Edge of the Quadrant, then will the Time be shewn, by the Index, when the Sun comes to the given Azimuth on the *shortest Day*, and is a little before IX in the Morning, with an Altitude of little more than 3° : Then revolve the Globe Westward till the most Northern Part of the *Analemma* touches the Edge of the Quadrant, (remaining still in the given Azimuth,) then will the Index shew the Time in which the Sun is upon that Azimuth on the *longest Day*, which will be about 35' after X, and the Altitude then will appear to be $55^{\circ} 30'$:—The Time of it's being on that Azimuth for any intermediate Day, and it's Height at that Time, will appear by stopping the Globe when the given Day comes to the Edge of the Quadrant.

Prob. XXXII. From the observed Altitude of the SUN, to find the HOUR and AZIMUTH in the given Latitude by the ANALEMMA.

Having rectified the Globe, as before directed, move the Globe and Quadrant of Altitude so together that the given Day of the Month may coincide with the given Degree of Altitude on the Edge of the Quadrant.

Thus

Thus, for Example; Suppose on the 20th of April in the Morning, you observe the Sun's Altitude 23° , then proceeding as directed, you will find the Index point to VIII in the Morning for the Time required, and the Quadrant will cut the Horizon in $77^{\circ} 30'$ at that Time.

A TABLE of the LATITUDES of PLACES, with their LONGITUDES; from the Meridian of the Royal Observatory at Greenwich; also the TIME of HIGH WATER at the FULL and CHANGE of the MOON, at those Places where it is known. From the REQUISITE TABLES, published by Order of the BOARD of LONGITUDE.

Names of Places.	Sea or Country.	Latitude.			Longitude.			High Wat.
		o	'	"	o	'	"	
Abbeville	France	50	7	1 N	1	49	45 E	
Abo	Finland	60	27	10 N	22	13	30 E	
Achem	Sumatra	5	22	0 N	95	34	0 E	
Adventure (Bay)	N. Holland	43	23	0 S	147	30	0 E	
Adventure (Isle)	Pacif. Ocean	17	5	15 S	144	17	45 W	
Agde	France	43	18	57 N	3	28	11 E	
Agen	France	44	12	7 N	0	35	49 E	
St. Agnes (Lights)	Scillies	49	56	0 N	6	46	0 W	
Agra	India	26	43	0 N	76	44	0 E	
Aire	France	43	31	35 N	5	26	34 E	
Aix	France	43	31	55 N	5	26	15 E	
Alby	France	43	55	44 N	2	8	45 E	
Aleppo	Turkey	35	45	23 N	37	20	0 E	
Alexandretta	Syria	36	35	10 N	36	20	0 E	
Alexandria	Egypt	31	11	20 N	30	16	30 E	
Algiers	Algiers	36	49	30 N	2	12	45 E	
Amboise	France	47	24	54 N	0	59	7 W	
Ambrym (Isle)	Pacif. Ocean	16	9	30 S	168	12	30 E	
Amiens	France	49	53	38 N	2	17	56 E	
Amsterdam	Holland	52	22	45 N	4	45	30 E	3 0
Amsterdam (Isle)	Pacif. Ocean	21	9	0 S	174	46	0 W	8 30
Ancona	Italy	43	37	54 N	13	30	30 E	
Angers	France	47	28	8 N	0	33	52 W	
Angouleme	France	45	39	3 N	0	8	45 E	
Angra	Tercera	38	39	0 N	27	12	15 W	
Annamocka	Pacif. Ocean	20	16	30 S	174	30	30 W	
St. Anthony's (Cape)	Staten Land	54	46	45 S				
Antibes	France	43	34	50 N	7	8	30 E	
Antigua (St. John's)	Carib. Sea	17	4	30 N	62	9	0 W	
Antwerp	Flanders	51	13	15 N	4	22	45 E	6 0
Anvers	Netherlands	51	13	15 N	4	24	15 E	
Apæ (Isle)	Pacif. Ocean	16	46	15 S	168	27	30 E	
Araçta	Turkey	36	1	0 N	38	50	0 E	
Archangel	Russia	64	34	0 N	38	55	0 E	6 0

Arica

G E O G R A P H Y. 73

Name of Places.	Sea or Country.	Latitude.			Longitude.			High Wat.	
		°	'	"	°	'	"	h	'
Arica	Peru	18	26	38 S	71	11	0 W		
Arles	France	43	40	33 N	4	38	0 E		
Arras	France	50	17	30 N	2	46	12 E		
Ascension (Isle)	S. Atl. Ocean	7	56	30 S	14	22	31 W		
Athens	Turkey	38	5	0 N	23	52	30 E		
Auch	France	43	38	46 N	0	34	36 E		
S. Augustine	Madagascar	23	35	29 S	43	8	0 E		
Aurillac	France	44	55	10 N	2	27	0 W		
Aurora (Isle)	Pacif. Ocean	15	8	0 S	162	17	0 E		
Autun	France	46	56	46 N	4	18	8 E		
Avignon	France	43	57	25 N	4	48	33 E		
Avranches	France	48	41	18 N	1	22	38 W		
Babylon (Ancient)	Mesopotamia	33	0	0 N	42	46	30 E		
Bagdad	Mesopotamia	33	20	0 N	43	46	30 E		
Balafore	India	21	20	0 N	86	0	0 E		
Ballabea (Isle)	N. Galedonia	20	7	0 S	164	22	0 E		
Banguet (Peak)	Malacca	7	18	0 N	117	17	30 E		
Barbas (Cape)	Sanhaga	22	15	30 N	16	40	0 W		
Barbuda (Isle)	Atl. Ocean	17	49	45 N	61	50	0 W		
Barcelona	Spain	41	26	0 N	2	13	0 E		
Barnevelt's (Isle)	Terra del Fuego	55	49	0 S	66	58	0 W		
St. Bartholomew (Isle)	N. Hebrides	15	42	0 S	167	17	30 E		
Basil	Switzerland	47	35	0 N	7	29	30 E		
Bassa Terre	Guadaloupe	15	59	30 N	61	59	15 W		
Batavia	Java	6	10	0 S	106	51	15 E		
Bath	England	51	22	30 N	2	21	30 W		
Bayeux	France	49	16	30 N	0	42	51 W		
Bayonne	France	43	29	21 N	1	30	6 W	3	30
Beachy Head	England	50	44	30 N	0	19	40 E	0	0
Bear Isle	Hudson's Bay	54	34	0 N	79	56	0 W	12	0
Beauvois	France	49	26	2 N	2	4	42 E		
Belle Isle	France	47	17	30 N	3	6	30 W	2	30
Bembridge Point	Isle of Wight	50	40	15 N	1	4	45 W		
Bencoolen	Sumatra	3	49	3 S	102	0	0 E		
Berlin	Germany	52	32	30 N	13	26	15 E		
Bermudas (Isle)	Atl. Ocean	32	35	0 N	63	28	0 W	7	0
Befanfon	France	47	13	45 N	6	2	40 E		
Befiers	France	43	20	41 N	3	12	35 E		
Blanco (Cape)	Negroland	20	55	30 N	17	10	0 W	9	45
Blanco (Cape)	Patagonia	47	20	0 S	64	42	0 W		
Blois	France	47	35	19 N	1	19	50 E		
Bojador (Cape)	Negroland	26	12	30 N	14	27	0 W	0	0
Bolabola (Isle)	Pacif. Ocean	16	32	30 S	151	52	0 W		
Bologna	Italy	44	29	36 N	11	21	15 E		
Bolcherefskoi	Siberia	52	54	30 N	156	37	30 E		
Bombay	India	18	56	40 N	72	38	0 E		
Bonavista (Isle)	Atl. Ocean	16	6	0 N	22	47	15 W		
Boston	New England	42	25	0 N	70	37	15 W		
Botany (Isle)	N. Caledonia	22	26	40 S	167	16	45 E		
Bologne	France	50	43	31 N	1	36	44 E	10	30
Bourbon (Isle)	Ind. Ocean	20	51	43 S	55	30	0 E		
Bourdeaux	France	44	50	18 N	0	34	49 W	0	3

L

Bourges—

Names of Places.	Sea or Country.	Latitude.			Longitude.			High Wat.
		°	'	"	°	'	"	
Bourges	France	47	4	58 N	2	23	26 E	
Breslaw	Silesia	51	3	0 N	17	8	45 E	
Brest	France	48	22	55 N	4	30	50 W	3 45
Bridge Town	Barbadoes	13	5	0 N	58	35	0 W	
St. Brieux	France	48	31	21 N	2	43	17 W	
Bristol (Cape)	Sandwich Land	59	2	30 S	26	51	0 W	
Brussels	Brabant	50	51	0 N	4	21	45 E	
Buenos Ayres	Brazil	34	35	26 S	58	31	15 W	
Bukaroff	Walachia	44	26	45 N	26	8	0 E	
Buller (Cape)	S. Georgia	53	58	30 S	37	40	0 W	
Burgeo (Isles)	Newfoundland	47	36	20 N	57	36	30 W	
Burlings	Portugal	39	20	0 N	9	36	45 W	
Cabello (Port)	Terra Firma	10	30	50 N	67	32	0 W	
Cadiz	Spain	36	31	7 N	6	11	50 W	4 30
Caen	France	49	11	10 N	0	21	47 W	9 0
Cahors	France	44	26	4 N	1	26	51 E	
Cairo	Egypt	30	2	44 N	31	18	16 E	
Calais	France	50	57	31 N	1	50	56 E	11 30
Callao	Peru	12	1	53 S	76	58	0 W	
Calcutta (F. Will.)	India	22	34	45 N	88	29	30 E	
Calmar	Sweden	56	40	30 N	16	21	45 E	
Cambray	France	50	10	52 N	3	13	41 E	
Cambridge	England	52	12	36 N	0	4	15 E	
Cambridge	N. England	42	25	0 N	71	10	0 W	
Canary (Isle) NE. P.	Canaries	28	13	0 N	15	38	45 W	3
Candia (Isle)	Medit. Sea	35	18	35 N	25	18	0 E	
Candlemas Isles	Sandwich Land	57	10	0 S	27	13	0 W	
Canfo (Port)	Nova Scotia	45	20	7 N	60	55	0 W	
Canton	China	23	7	50 N	113	2	15 E	
Carlescroon	Sweden	56	20	0 N	15	26	15 E	
Carthagera	Spain	37	37	0 N	1	8	30 W	
Carthagera	Terra Firma	10	26	35 N	75	26	45 W	
Casan	Siberia	55	43	58 N	49	8	15 E	
Cassel	Germany	51	19	4 N	9	29	0 E	
Castres	France	43	37	10 N	2	14	45 E	
St. Catherines Isles	Atl. Ocean	27	35	0 S	49	17	0 W	
Cavan	Ireland	54	51	41 N	7	23	0 W	
Cayenne	Isle Cayenne	4	56	0 N	52	15	0 W	
Cette	France	43	23	51 N	3	42	7 E	
Challon	France	46	46	50 N	4	51	25 E	
Chalons	France	48	57	12 N	4	22	12 E	
Chandernagor	India	22	51	26 N	88	29	15 E	
Q. Charlotte Sound	N. Zealand	41	5	58 S	174	13	32 E	9
Q. Charl. Foreland	N. Caledonia	22	15	0 S	167	12	45 E	
Q. Charlotte's Cape	S. Georgia	54	32	0 S	36	11	30 W	
Charlton Isle	Hudson's Bay	52	3	0 N	79	5	0 W	
Chartres	France	48	26	49 N	1	28	55 E	
Cherbourg	France	49	38	26 N	1	38	11 W	7 30
Christmas Sound	Terra del Fuego	55	21	57 S	70	2	50 W	2 30
St. Christopher's (Isle)	Carib. Sea	17	15	0 N	62	43	0 W	
Churchill River	Hudson's Bay	58	47	32 N	94	7	30 W	7 20
Civita Vecchia	Italy	42	5	24 N	11	46	15 E	

Names

G E O G R A P H Y.

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Names of Places.	Sea or Country.	Latitude.			Longitude.			High Wat.
		°	'	"	°	'	"	
Cape Clear	Ireland	51	18	0 N	11	15	0 W	4 30
Clerke's Isles	Atl. Ocean	55	5	30 S	34	42	0 W	
Clermont	France	45	46	45 N	3	5	7 E	
Cape Colenet	N. Caledonia	20	30	0 S	164	56	0 E	
Colmar	France	48	4	44 N	7	22	11 E	
Cologne	Germany	50	55	0 N	7	5	0 E	
Cape Comerin	India	7	56	0 N	78	5	0 E	
Compeigne	France	49	24	59 N	2	49	41 E	
Conception	Chili	36	52	53 S	72	40	0 W	
Cooper's Isle	Atl. Ocean	54	57	0 S	36	4	20 W	
Constantinople	Turkey	41	1	24 N	28	53	49 E	
Copenhagen	Denmark	55	40	45 N	12	35	15 E	
Coquimbo	Chili	29	54	26 S	71	15	45 W	
Cork	Ireland	51	53	54 N	8	28	15 W	6 30
Cape Coronation	N. Caledonia	22	5	0 S	167	8	0 E	
Corvo	Azores	39	42	0 N	31	6	0 W	
Coutances	France	49	2	50 N	1	27	25 W	
Cowes	Isle of Wight	50	46	20 N	1	19	45 W	10 30
Cracow	Poland	50	10	0 N	19	50	0 E	
Cremsmunster	Germany	48	3	29 N	14	7	0 E	
Croific	France	47	17	40 N	2	31	42 W	
Cumberland (Cape)	N. Hebrides	14	39	30 S	166	47	0 E	
Cummin (Isle)	Pacif. Ocean	31	40	0 N	121	4	0 E	
D antzic	Poland	54	22	0 N	18	33	37 E	
Daften Island	Caniers	33	25	0 S	18	2	0 E	
Dax	France	43	42	23 N	1	3	55 W	
St. Dennis	I. Bourbon	20	51	43 S	55	30	0 E	
Diego (Cape)	Terra del Fuego	54	33	0 S	65	14	0 W	
Dieppe	France	49	55	17 N	1	4	12 E	10 30
Dijon	France	47	19	22 N	5	2	23 E	
Dillingen	Germany	48	30	0 N	10	14	30 E	
Disappointm. (Cape)	So. Georgia	54	58	0 S	36	15	0 W	
Disseada (Cape)	Terra del Fuego	55	4	15 S	74	18	0 W	
Dol	France	48	33	9 N	1	46	12 W	
Dominique (Isle)	Windward Isles	15	18	23 N	61	27	55 W	
Douay	Flanders	50	22	12 N	3	4	47 E	
Dover	England	51	7	47 N	1	18	30 E	11 30
Dreux	France	48	44	17 N	1	21	24 E	
Drontheim	Norway	63	26	10 N	11	3	45 E	
Dublin	Ireland	53	21	11 N	6	6	30 W	9 15
Dungeness	England	50	52	20 N	0	59	6 E	0 45
Dunkirk	France	51	2	4 N	2	22	23 E	0 0
Duskey Bay	N. Zealand	45	47	27 S	166	18	9 E	10 57
Dannofe	England	50	33	30 N	1	16	20 W	9 45
E aooe (Isle)	Pacif. Ocean	21	24	0 S	174	30	0 W	
Easter Island	Pacif. Ocean	27	6	30 S	109	46	45 W	2 0
Edinburg	Scotland	55	57	57 N	3	12	15 W	4 30
Edystone	Eng. Channel	50	8	0 N	4	24	0 W	5 30
Embrun	France	44	34	0 N	6	29	0 E	
Enatum (Isle)	Pacif. Ocean	20	10	0 S	170	4	0 E	
English Road	Eaooe	21	20	30 S	174	34	0 W	

L 2

Name,

Names of Places.	Sea or Country.	Latitude.			Longitude.			High Wat.
		°	'	"	°	'	"	
Erramango (Isle) —	Pacif. Ocean —	18	46	30 S	169	18	30 E	
Erzerum —	Armenia —	39	56	35 N	48	35	45 E	
Eutachia (Town) —	Cr b. Sea —	17	29	0 N	63	30	0 W	
Evout's Isles —	Terra del Fuego —	55	34	30 S	66	39	0 W	
Evereux —	France —	49	1	24 N	1	8	39 E	
Exeter —	England —	50	44	0 N	3	34	30 W	
F almouth —	England —	50	8	0 N	5	2	30 W	5 30
Falfe (Cape) —	Caffres —	34	16	0 S	18	44	0 E	
Falfe Bay —	Caffres —	34	10	0 S	18	33	0 E	
Farewell (Cape) —	Greenland —	59	38	0 N	42	42	0 W	
Farewell (Cape) —	N. Zealand —	40	37	0 S	172	41	30 E	
Fayal Town —	Azores —	38	32	20 N	28	41	5 W	2 20
Ferdinand Noronha —	Brazil —	3	56	20 S	32	38	0 W	
Ferrara —	Italy —	44	54	0 N	11	36	15 E	
Ferro Isle (Town) —	Canaries —	27	47	20 N	17	45	50 W	
Finisterre (Cape) —	Spain —	42	51	52 N	9	17	10 W	
Florence —	Italy —	43	46	30 N	11	2	0 E	
Flores —	Azores —	39	34	0 N	31	0	0 W	
St. Flour —	France —	45	1	55 N	3	5	30 E	
Fortaventure (W.Pt.) —	Canaries —	28	4	0 N	14	31	30 W	
Foul Point —	Madagascar —	17	40	14 S	49	53	0 E	
France (Isle of) —	Indian Ocean —	20	9	45 S	57	28	0 E	
Francfort (on the Ma.) —	Germany —	49	55	0 N	8	35	0 E	
Francois (Cape) —	Hispaniola —	19	46	30 N	72	18	0 W	
Old Cape Francois —	Hispaniola —	19	40	30 N	70	2	0 W	
Frauenburgh —	Prussia —	54	21	15 N	20	7	30 E	
Frejus —	France —	43	26	3 N	6	44	45 E	
Frekel (Cape) —	France —	48	41	3 N	6	0	0 W	
Friesland's Peak —	Sandw. Land —	59	2	0 S	26	55	30 W	
Fronsac (Strait) —	Nova Scotia —	45	36	57 N	61	19	30 W	
Fuego (Isle) —	Cape Verd —	14	56	45 N	24	28	0 W	
Funchal —	Madeira —	32	37	40 N	17	6	15 W	12 4
Furneaux Island —	Pacif. Ocean —	17	11	0 S	143	6	40 W	
G ap —	France —	41	33	50 N	6	4	57 E	
Gabey —	New Guinea —	0	6	0 S	126	23	45 E	
Genes —	Italy —	44	25	0 N	8	35	45 E	
Geneva —	Savoy —	46	12	0 N	6	0	0 E	
Genoa —	Italy —	44	25	0 N	8	35	45 E	
St. George (Isle) —	Azores —	38	39	0 N	28	0	0 W	
St. George (Town) —	Bermudas —	32	45	0 N	63	35	0 W	
St. George (Fort) —	India —	13	4	54 N	80	28	45 E	
St. George (Cape) —	New Britain —	4	53	30 S	153	8	45 E	
George (Cape) —	South Georgia —	54	17	0 S	36	32	30 W	
Ghent —	Flanders —	51	3	0 N	3	43	45 E	
Gibraltar —	Spain —	36	5	30 N	5	22	0 W	0
Gilbert's Isle —	Terra del Fuego —	55	13	0 S	71	6	45 W	
Glasgow —	Scotland —	55	51	32 N	4	15	0 W	
Goa —	India —	15	31	0 N	73	45	0 E	
Goat Isle —	Indian Ocean —	13	55	0 N	120	2	0 E	
Gomera (Isle) —	Canaries —	28	5	40 N	17	8	0 W	
Good Hope (Cape) —	Caffree —	34	29	0 S	18	23	15 E	3 0

Good

Names of Places.	Sea or Country.	Latitude.			Longitude.			High Wat.	
		°	'	"	°	'	"	h	'
Good Hope (Town)	Caffres	33	55	42 S	18	23	15 E	2	30
Goree (Isle)	Atl. Ocean	14	40	10 N	17	25	0 W	1	30
Gottenburg	Sweden	57	42	0 N	11	38	45 E		
Gottengen (Obfer.)	Germany	51	31	54 N	9	53	0 E		
Granville	France	48	50	11 N	1	37	7 W	7	•
Grafie	France	43	39	25 N	6	56	0 E		
Gratofa	Azores	39	2	0 N	27	58	0 W		
Gratz	Germany	47	4	18 N	15	24	44 E		
Gravelines	Flanders	50	59	4 N	2	7	32 E	0	•
Greenwich (Obfer.)	England	51	28	40 N	0	0	0		
Grenoble	France	45	11	49 N	5	43	40 E		
Gryphiswald	Germany	54	4	25 N	13	38	30 E		
Guadeloupe	Carib. Sea	15	59	30 N	61	59	15 W		
Guiaquil	Peru	2	11	21 S	81	11	30 W		
Guriot	Siberia	47	7	8 N	51	57	0 E		
H ague	Netherlands	52	4	10 N	4	17	30 E	8	15
Hamburg	Netherlands	53	34	8 N	9	50	0 E	6	0
Hang-lip (Cape)	Caffres	34	16	0 S	18	44	0 E		
Harborough (Mark)	England	52	28	30 N	0	57	25 W		
Hastings	England	50	52	10 N	0	41	10 E		
Havannah	Cuba	23	11	52 N	82	18	30 W		
Havre-de-grace	France	49	29	9 N	0	5	57 E	9	0
Heefe (La)	Netherland	51	23	2 N	4	45	30 E		
St. Helena (J. Town)	S. Atl. Ocean	15	55	0 S	5	49	0 W		
Henlopen (Cape)	Virginia	38	47	8 N	75	4	15 W		
Hernofand	Sweden	62	38	0 N	17	53	0 E		
Hervey's Isle	Pacif. Ocean	19	17	0 S	158	48	0 W		
Hinchinbroke Isle	Pacif. Ocean	17	25	0 S	168	38	0 E		
Hoai-Nghan	China	33	34	40 N	118	49	30 E		
Hogue (Cape La)	France	49	44	40 N	1	56	50 W		
Hood's Isle	Pacif. Ocean	9	26	0 S	138	52	0 W		
Hoogstraeten	Netherlands	51	24	44 N	4	47	0 E		
Horn (Cape)	Terra del Fuego	55	58	30 S	67	26	0 W		
Hout Bay	Caffres	34	3	0 S	18	19	0 E		
Howe's Isle	Pacif. Ocean	16	46	30 S	154	6	40 W		
Huahine (Isle)	Pacif. Ocean	16	44	0 S	151	6	0 W		
J akutskoi	Siberia	62	1	30 N	129	47	45 E		
Janeiro (Rio)	Brazil	22	54	10 S	42	43	45 W		
Jaffy	Moldavia	47	8	30 N	27	29	45 E		
Java Head	Java	6	49	0 S	106	50	0 E		
Jerusalem	Palestine	31	55	0 N	35	20	0 E		
St. Ildefonso's Isles	Terra del Fuego	35	51	0 S	69	21	0 W		
Immer (Isle)	Pacific Ocean	19	16	0 S	169	46	0 E		
Ingolstadt	Germany	48	45	45 N	11	22	30 E		
St. John's	Antigua	17	4	30 N	62	9	0 W		
St. John's	Newfoundland	47	32	0 N	52	26	0 W	6	•
St. Joseph's	California	23	3	42 S	109	42	30 W		
Irraname (Isle)	Pacific Ocean	19	31	0 S	170	21	0 E		
Islamabad	India	22	20	0 N	91	45	0 E		
Isle of Pines	Pacific Ocean	22	38	0 S	167	38	0 E		
Ispahan	Perfia	32	25	0 N	52	50	0 E		

St.

78 G E O G R A P H Y.

Names of Places.	Sea or Country.	Latitude.	Longitude.	High Wat.
		° ' "	° ' "	h ' "
St. Juan (Cape) —	Staten Land —	54 47 10 S	63 47 0 W	
Judda —	Arabia —	21 29 0 N	39 22 0 E	
St. Julian (Port) —	Patagonia —	49 10 0 S	68 44 0 W	4 45
Juthia —	India —	14 18 0 N	100 50 0 E	
K edgersee —	India —	21 48 0 N	88 50 15 E	
Kiow —	Ukraine —	50 30 0 N	31 7 30 E	
Kola —	Lapland —	68 52 30 N	33 8 0 E	
L adrone (Grand) —	Pacific Ocean —	22 2 0 N	113 56 0 E	
Laguna —	Teneriffe —	28 28 57 N	16 18 15 W	
Lancerota (E. Pt.) —	Canaries —	29 14 0 N	13 26 0 W	
Landau —	France —	49 11 38 N	8 7 30 E	
Landscroon —	Sweden —	55 52 0 N	12 46 45 E	
Langres —	France —	47 52 17 N	5 19 23 E	
Lausanne —	Switzerland —	46 31 5 N	6 45 15 E	
Leftoure —	France —	43 56 2 N	0 36 53 E	
Leeds —	England —	53 48 0 N	1 34 15 W	
Leicester —	England —	52 38 0 N	1 8 30 W	
Leipfic —	Saxony —	51 19 14 N	12 20 0 E	
Leper'e Island —	Pacific Ocean —	15 23 30 S	167 58 15 E	
Leskeard —	Englnd —	50 26 55 N	4 41 45 W	
Lesparre —	France —	45 18 33 N	0 27 3 W	
Leyden —	Holland —	52 10 0 N	4 27 30 E	
Liege —	Netherlands —	50 37 30 N	5 35 0 E	
Lima —	Peru —	12 1 15 S	76 49 30 W	
Limoges —	France —	45 49 53 N	1 15 9 E	
Lingtz —	Germany —	48 16 0 N	13 57 30 E	
Lisieux —	France —	49 11 0 N	0 15 0 E	
Lisle —	Flanders —	50 37 50 N	3 4 16 E	
Lisbon —	Portugal —	38 42 25 N	9 9 59 W	2 15
Lion's Bank —	Atl. Ocean —	56 40 0 N	17 45 0 W	
Lisburne (Cape) —	N. Hebrides —	15 40 45 S	166 57 0 E	
Lizard —	England —	49 57 30 N	5 15 0 W	7 30
Lombes —	France —	43 28 30 N	0 55 9 E	
London (St. Paul's) —	England —	51 31 0 N	0 5 37 W	3 •
Lorenzo (Cape) —	Peru —	1 2 0 S	80 17 0 W	
St. Louis (Port) —	Hispaniola —	18 18 50 N	73 16 0 W	
St. Louis (Port) —	Mauritius —	20 9 45 S	57 28 0 E	
Louisburg —	Cape Breton —	45 53 39 N	59 53 45 W	
Louveau —	India —	12 42 30 N	101 1 30 E	
Louvain —	Netherlands —	50 53 3 N	4 44 15 E	
St. Lucia (Isle) —	Antilles —	13 24 30 N	60 51 30 W	
Lunden —	Sweden —	55 41 36 N	13 21 15 E	
Luneville —	France —	48 35 33 N	6 30 6 E	
Lufon —	France —	46 27 14 N	1 10 34 W	
Luxembourg —	Netherlands —	49 37 6 N	6 11 45 E	
Lyons —	France —	45 45 51 N	4 49 43 E	
M acao —	China —	22 12 44 N	113 46 15 E	
Macassar —	Celebes —	5 9 0 S	119 48 45 E	
Madeira (Funchal) —	Atl. Ocean —	32 37 40 N	17 6 15 W	12 6
Madrafs —	India —	13 4 54 N	80 28 45 E	
				Madre

Names of Places.	Sea or Country.	Latitude.			Longitude.			High Wat.	
		°	'	"	°	'	"	h	'
Madre de Oios (Port)	Marquesas	9	55	30 S	139	8	40 W	2	30
Madrid	Spain	40	25	0 N	3	25	45 W		
Magdalena (Isle)	Pacific Ocean	10	25	30 S	138	49	0 W		
Mahon (Port)	Minorca	39	50	46 N	3	48	30 E		
Majorca (Isle)	Mediterr. Sea	39	35	0 N	2	29	45 E		
Malacca	India	2	12	6 N	102	5	0 E		
Malines	Netherlands	51	1	50 N	4	28	45 E		
Mallicola (Isle)	Pacific Ocean	16	15	30 S	167	39	15 E		
St. Maloes	France	48	38	59 N	2	2	22 W	6	
Malta (Isle)	Mediterr. Sea	35	54	0 N	14	28	30 E		
Manilla	Philippines	14	36	8 N	120	53	24 E		
Marigalante (Isle)	Atl. Ocean	15	55	15 N	61	11	0 W		
Marseille's	France	43	17	45 N	5	22	8 E		
St. Martha	Terra Firma	11	26	40 N	74	4	30 W		
St. Martin's (Isle)	Carib Sea.	18	4	20 N	63	2	0 W		
Martinico (Isle)	Atl. Ocean	14	44	0 N	61	21	16 W		
St. Mary's (Isle)	Scilly Isles	49	57	30 N	6	43	0 W	3	45
St. Mary's (Town)	Azores	36	56	40 N	25	9	15 W		
Makelyne's Isle	Pacific Ocean	16	32	0 S	167	59	15 E		
St. Matthew (Lights)	France	48	19	52 N	4	47	25 W		
Mauritius	Indian Ocean	20	9	45 S	57	29	15 E		
Maurus (Isle)	Pacific Ocean	16	25	40 S	152	32	40 W		
Mayance	Germany	49	54	0 N	8	20	0 E		
Mayne (John's) Isle	North Ocean	71	10	0 N	9	49	30 W		
Mayo (Isle)	Cape Verd	15	10	0 N	23	5	0 W		
Meaux	France	48	57	37 N	2	52	35 E		
Mende	France	44	30	47 N	3	29	32 E		
Mergui	Siam	12	12	0 N	98	8	45 E		
Metz	France	49	7	5 N	6	11	0 E		
Mew Stone	New Holland	43	48	0 S	146	27	0 E		
Mexico	Mexico	19	54	0 N	100	5	45 W		
Mezieres	France	49	45	47 N	4	43	16 E		
Miatea (Isle)	Pacif. Ocean	17	52	0 S	148	6	0 W		
St. Michel's (Isle)	Azores	37	47	0 N	25	42	0 W		
Middleburg (Isle)	Pacif. Ocean	21	20	30 S	174	34	0 W		
Milan	Italy	45	28	10 N	9	10	0 E		
Milo (Isle)	Medit. Sea	36	41	0 N	25	0	0 E		
Modena	Italy	44	34	0 N	11	12	30 E		
Mons	Netherlands	50	27	10 N	3	57	15 E		
Montagu (Cape)	Sandw. Land	58	33	0 S	26	46	0 W		
Montagu (Isle)	Pacif. Ocean	17	26	0 S	168	31	30 E		
Montmirail	France	48	52	8 N	3	32	16 E		
Montpellier	France	43	36	33 N	3	52	44 E		
Montferrat (Isle)	Carib. Sea	16	47	30 N	62	17	0 W		
Monument (The)	Pacif. Ocean	17	14	15 S	168	38	15 E		
Moscow	Moscovy	55	45	20 N	37	45	45 E		
Moulins	France	46	34	4 N	3	19	59 E		
Munich	Bavaria	48	9	55 N	11	30	0 E		
Musketto Cove	Greenland	64	55	13 N	52	56	45 W	10	15
Muswell Hill	England	51	35	32 N	0	7	20 W		
Namur	Netherlands	50	28	32 N	4	44	45 E		
Nancy	France	48	41	28 N	6	11	33 E		
Nangasachi,	Japan	32	22	0 N	128	46	15 E		

Nantes

Names of Places.	Sea or Country.	Latitude.			Longitude.			High War.
		°	'	"	°	'	"	
Nantes	France	47	13	7 N	1	33	48 W	3 °
Naples	Italy	40	50	45 N	14	13	45 E	
Narbonne	France	43	11	13 N	3	0	8 E	
Nevers	France	46	59	13 N	3	9	25 E	
New Year's Harbour	Staten Land	54	48	55 S	64	11	0 W	
Nice	France	43	41	54 N	7	17	15 E	
St. Nicholas Mole	Hispaniola	19	49	20 N	73	29	45 W	
Nieuport	Flanders	51	7	41 N	2	45	0 E	12 °
Ningpo	China	29	57	45 N	120	18	0 E	
Nismes	France	43	50	35 N	4	21	11 E	
Noir (Cape)	Terra del Fuego	54	32	30 S	73	3	15 W	
Norfolk Island	Pacif Ocean	29	1	45 N	168	10	0 E	
Noriton	Pensylvania	40	9	56 N	75	23	30 W	
North Cape	Lapland	71	10	0 N	25	57	0 E	3 °
Cape North	South Georgia	54	4	45 N	38	15	0 W	
Noyon	France	49	34	37 N	3	0	43 E	
Nuremberg	Germany	49	27	10 N	11	7	0 E	
O aitipeha Bay	Otaheite	17	45	45 S	149	14	20 W	
Ochoz	Tartary	59	20	10 N	143	12	30 E	
Ohamaneno Harbour	Uliateah	16	45	30 S	151	38	5 W	11 20
Ohevahoa (Isle)	Pacif. Ocean	9	40	40 S	139	1	40 W	
Ohitahoo (Isle)	Pacif. Ocean	9	55	30 S	139	6	0 W	2 30
Oleron (Isle)	France	46	2	50 N	1	25	13 W	
Olinde	Brazil	8	13	0 S	35	5	30 W	
St. Omer's	Flanders	50	44	46 N	2	14	57 E	
Onateayo (Isle)	Pacif. Ocean	9	58	0 S	138	51	0 W	
Oporto	Portugal	41	10	0 N	8	27	0 W	
Orenburg	Tartary	51	46	0 N	55	9	30 E	
Orleans	France	47	54	4 N	1	54	22 E	
Orleans (New)	Louifiana	29	57	45 N	89	58	45 W	
Orotova	Teneriffe	28	23	27 N	16	24	11 W	
Orsk	Tartary	51	12	30 N	58	32	30 E	
Ortagal (Cape)	Spain	43	46	30 N	7	39	0 W	
Osnaburg (Isle)	Pacif. Ocean	17	52	20 S	148	6	0 W	
Ostend	Netherlands	51	13	55 N	2	55	45 E	12 °
Owharre Bay	Huahine	16	44	15 S	151	8	15 W	
Oxford (Observatory)	England	51	45	38 N	1	15	30 W	
P adua	Italy	45	22	26 N	11	55	30 E	
Paita	Peru	5	12	0 S				
Palliser's (Isle)	Pacific Ocean	15	38	15 S	146	30	15 W	
Palliser (Cape)	N. Zealand	41	38	0 S	175	18	0 E	
Palma (Isle)	Canaries	28	36	45 N	17	50	0 W	
Palmerston (Isle)	Pacific Ocean	13	0	0 S	162	57	0 W	
Panama	Mexico	8	47	48 N	80	21	0 W	
Paoom (Isle)	Pacific Ocean	16	30	0 S	168	28	45 E	
Paris (Observ.)	France	48	50	14 N	2	20	0 E	
Patixford	Iceland	65	35	45 N	24	10	0 W	
Pau	France	43	15	0 N	0	9	0 W	
St. Paul's (Isle)	Ind. Ocean	37	51	0 S	77	48	0 E	
St. Paul de Leon	France	48	40	55 N	4	0	21 W	4 °
Pekin	China	39	55	30 N	116	24	15 E	

Perigeux

G E O G R A P H Y. 81

Names of Places	Sea or Country.	Latitude.			Longitude.			High Wat.	
		°	'	"	°	'	"	h.	'
Perigeeux	France	45	11	10 N	0	43	1 E		
Perinaldi	Italy	43	53	20 N	7	40	0 E		
Perpignan	France	42	41	55 N	2	54	5 E		
St. Peter's Fort	Martinico	14	44	0 N	61	21	16 W		
St. Peter's (Isle)	Atl. Ocean	46	46	30 N	56	17	0 W		
Petersburg	Russia	59	56	0 N	30	19	15 E		
Petit Goave	Hispaniola	18	27	0 N	72	52	30 W		
Petropawlofskoi	Kamchatka	53	1	20 N	158	35	0 E		
Philadelphia	Pensylvania	39	56	55 N	75	13	30 W		
St. Philip's Fort	Minorca	39	50	46 N	3	48	30 E		
Pickersgill's (Isle)	Atl. Ocean	54	42	30 S	36	58	0 W		
Pickersgill's Harbour	N. Zealand	55	47	27 S	166	18	9 E		
Pico	Azores	38	28	40 N	28	26	0 W		
Pines (Isle)	N. Caledonia	22	38	0 S	167	38	0 E		
Pisa	Italy	43	43	7 N	10	12	0 E		
Plymouth	England	50	22	24 N	4	15	38 W	6	
Poitiers	France	46	35	0 N	0	20	5 E		
Pollingen	Germany	47	48	8 N	10	43	45 E		
Pondicherry	India	11	41	55 N	79	52	45 E		
Ponoi	Lapland	67	6	30 N	36	23	15 E		
Pontoise	France	49	3	2 N	2	5	37 E		
Porto Bello	Mexico	9	33	5 N	79	50	0 W		
Porto Saneto (Isle)	Madeira	32	58	15 N	16	25	15 W		
Port Royal	Jamaica	18	0	0 N	76	45	30 W		
Port Royal	Martinico	14	35	55 N	61	9	0 W		
Portsmouth Town	England	50	47	5 N	1	6	15 W	11	15
Academy	England	50	48	3 N	1	6	18 W		
Portland (Isle)	North Sea	63	22	0 N	18	54	0 W		
Portland (Isle)	Pacific Ocean	39	23	0 S	178	12	0 E		
Port Paix	Hispaniola	19	58	0 N	73	2	0 W		
Port Praya	St. Jago	14	53	53 N	23	29	22 W	11	0
Prague	Bohemia	50	4	30 N	14	45	0 E		
Prince of Wales's Fort	New Wales	58	47	32 N	94	7	30 W		
Providence	N. England	41	50	40 N	71	26	0 W		
Pudyoua	N. Caledonia	20	18	0 S	164	41	14 E	6	30
Pulo Condor (Isle)	India Ocean	8	40	0 N	107	20	0 E		
Pulo Timon (Isle)	Gulph Siam	3	0	0 N	104	25	0 E		
Pylestauat's (Isle)	Pacific Ocean	21	23	0 S	175	41	30 W		
Quebec	Canada	46	55	0 N	69	53	0 W	7	30
Quimper	France	47	58	24 N	4	7	25 W		
St. Quinton	France	49	50	51 N	3	17	23 E		
Quiros (Capr)	N. Hebrides	14	56	8 S	167	20	0 E		
Quito	Peru	0	13	17 S	77	55	0 W		
Rakah (Ancient)	Mesopotamia	30	1	0 N	38	50	0 E		
Ramhead	England	50	18	40 N	4	20	15 W		
Re (Isle)	France	46	14	48 N	1	34	28 W	3	0
Recif	Brazil	8	10	0 S	35	35	0 W		
Reikianefs (Cape)	Iceland	63	55	0 N	22	47	30 W		
Rennes	France	48	6	45 N	1	41	53 W		
Resolution (Bay)	Ohitahoo	9	55	30 S	139	8	40 W	2	30

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Resolution

Names of Places.	Sea or Country.	Latitude.			Longitude.			High Wat.	
		°	'	"	°	'	"	h	'
Resolution (Isle) —	Pacific Ocean —	17	23	30 S	141	45	0 W		
Resolution (Port) —	Tanna —	19	32	25 S	169	41	5 E		
Rheims —	France —	49	14	36 N	4	2	53 E		
Rhodes —	France —	44	21	0 N	2	34	20 E		
Rimini —	Italy —	44	3	43 N	12	34	15 E		
Rio Janeiro —	Brazil —	22	34	0 S	42	43	45 W		
Rochelle —	France —	46	9	21 N	1	9	55 W	3	45
Rochford —	France —	46	2	34 N	0	58	34 W	4	15
Rock of Lisbon —	Portugal —	38	45	30 N	9	35	30 W		
Rodrigues (Isle) —	Indian Ocean —	19	40	40 S	63	10	0 E		
Rome (St. Peter's) —	Italy —	41	53	54 N	12	29	15 E		
Rotterdam —	Holland —	51	56	0 N	4	28	15 E	3	0
Rotterdam (Isle) —	Pacific Ocean —	20	16	30 S	174	30	30 W		
Rouen —	France —	49	26	43 N	1	5	20 W	1	25
S aba (Isle) —	Carib Sea —	17	39	30 N	63	17	15 W		
Sable (Cape) —	Nova Scotia —	43	23	45 N	65	39	15 W		
Sagan —	Silesia —	51	42	12 N	15	22	15 E		
Saintes —	France —	45	44	43 N	0	38	54 W		
Sainte Croix —	France —	48	0	35 N	7	23	55 E		
Sall (Isle) —	Atl. Ocean —	16	38	15 N	22	56	15 W		
Salonique —	Turkey —	40	41	10 N	23	8	0 E		
Salvages (Isles) —	Atl. Ocean —	30	0	0 N	15	54	0 W		
Sumana —	Hispaniola —	19	15	0 N	69	16	30 W		
Santa Cruz —	Teneriffe —	28	27	30 N	16	16	15 W		
Sandwich (Bay) —	South Georgia —	54	42	0 S	36	12	0 W		
Sandwich (Cape) —	Mallicola —	16	28	0 S	167	59	0 E		
Sandwich Harbour —	Mallicola —	16	25	20 S	167	53	0 E		
Sandwich (Isles) —	Pacific Ocean —	17	41	0 S	168	33	0 E		
Saunders (Cape) —	Sandw. Land —	54	6	30 S	36	57	30 W		
Saunders (Isle) —	South Georgia —	58	0	0 S	26	58	0 E		
Savage (Isle) —	Pacific Ocean —	19	2	15 S	169	30	30 W		
Schwezingen —	Germany —	49	23	4 N	8	40	45 E		
Scilly Isles (Lights) —	English Channel —	49	56	0 N	6	46	0 W		
Sebastian St. (Cape) —	Madagascar —	12	30	0 S	46	25	0 E		
Sedan —	France —	49	42	29 N	4	57	36 E		
Seez —	France —	48	36	21 N	0	9	49 E		
Senegal —	Negroland —	15	53	0 N	16	31	30 W	10	30
Senlis —	France —	49	12	23 N	2	35	0 E		
Sens —	France —	48	11	56 N	3	16	58 E		
Senones —	France —	48	23	7 N	6	57	0 E		
Shepherd's (Isles) —	Pacific Ocean —	16	58	0 S	168	42	0 E		
Shirburn Castle —	England —	51	39	25 N	1	0	0 W		
Siam —	India —	14	18	0 N	100	50	0 E		
Singham-fu —	China —	34	16	30 N	108	43	45 E		
Sisteron —	France —	44	11	21 N	5	56	4 E		
Smyrna —	Natolia —	38	28	7 N	27	19	45 E		
Snæfell (Mount) —	Iceland —	64	52	20 N	23	54	0 W		
Soissons —	France —	49	22	32 N	3	19	28 E		
Somtavera (Isles) —	Carib. Sea —	18	38	0 N	63	37	30 W		
Soolo —	India —	5	57	0 N	121	15	30 E		
Southern Thule —	Sandw. Land —	59	34	0 S	27	45	0 W		
Speaker Bank —	Indian Ocean —	4	45	0 S	72	57	0 E		

Statbridge

Names of Places.	Sea or Country.		Latitude.			Longitude.			High War.
			°	'	"	°	'	"	
Stalbridge	—	England	—	50	57	0	N	2 23 30	W
Start Point	—	England	—	50	9	0	N	3 51 15	W
Stockholm	—	Sweden	—	59	20	31	N	18 3 55	E
Straumnefs	—	Iceland	—	65	39	40	N	24 29 15	W
S. ratibourg	—	France	—	48	34	36	N	7 46 18	E
Succes Bay	—	Terra del Fuego	—	54	49	45	S	65 25 0	W
Succes Cape	—	Terra del Fuego	—	55	1	0	S	65 27 0	W
Sultz	—	France	—	47	53	10	N	7 14 32	W
Surat	—	India	—	21	10	0	N	72 22 30	E
T able Island	—	N. Hebrides	—	15	38	0	S	167 7 0	E
Tanna	—	Pacific Ocean	—	19	32	2	S	169 41 5	E
Taoukaa (Isle)	—	Pacific Ocean	—	14	30	30	S	145 9 30	W
Tarafcon	—	France	—	43	48	20	N	4 39 36	E
Tarbes	—	France	—	43	14	2	N	0 3 33	E
Tassacorta	—	Isle Palma	—	28	38	0	N	17 58 0	W
Temontengis	—	Soloo	—	5	57	0	N	120 53 30	E
Teneriffe (Peak)	—	Canaries	—	28	12	54	N	16 29 24	W
Tercera	—	Azores	—	38	45	0	N	27 6 0	W
Thionville	—	France	—	49	21	30	N	6 10 30	E
Thomas St. (Isle)	—	Virginia Isles	—	18	21	55	N	64 51 30	W
Thule (Southern)	—	Sandwich Land	—	59	34	0	S	27 45 0	W
Thury	—	France	—	49	21	28	N	2 18 30	E
Timer (St. W. Point)	—	India	—	10	23	0	S	123 59 0	E
Tlmor Land (S. Poi.)	—	India	—	8	15	0	S	131 54 0	E
Tobolski	—	Siberia	—	58	12	18	N	68 12 45	E
Tolaga Bay	—	N. Zealand	—	38	21	30	S	178 33 5	E
Toledo	—	Spain	—	39	50	0	N	3 20 0	W
Tomsk	—	Siberia	—	56	29	58	N	84 59 30	E
Tonga Tabu (Isle)	—	Pacific Ocean	—	21	9	0	S	174 46 0	W
Tonnerre	—	France	—	47	51	8	N	3 58 4	E
Tornea	—	Sweden	—	65	50	50	N	24 12 0	E
Toulon	—	France	—	43	7	24	N	5 56 35	E
Toulouse	—	France	—	43	35	54	N	1 21 3	E
Tournan	—	France	—	48	43	57	N	2 45 15	E
Tours	—	France	—	47	23	44	N	0 41 11	E
Traitor's Head	—	Erramanga	—	18	43	30	S	169 20 30	E
Tripoli	—	Barbary	—	32	53	40	N	13 5 15	E
Troyes	—	France	—	48	18	2	N	4 4 55	E
Turin	—	Italy	—	45	5	20	N	7 40 0	E
Turnagain (Cape)	—	N. Zealand	—	40	28	0	S	176 56 0	E
Turtle Island	—	Pacific Ocean	—	19	48	45	S	17 57 0	W
Tyrnaw	—	Hungary	—	48	23	30	N	17 33 45	E
U liateah	—	Pacific Ocean	—	16	45	0	S	151 31 0	W
Upsal	—	Sweden	—	59	51	50	N	17 42 15	E
Uraniburg	—	Denmark	—	55	54	15	N	12 52 30	E
Ushant	—	France	—	48	28	30	N	5 4 31	W
V alenciennes	—	France	—	50	21	27	N	3 31 40	E
Valery St.	—	France	—	50	11	13	N	1 37 6	E
Vallery St.	—	France	—	49	52	12	N	0 41 10	E
Valparaifo	—	Chili	—	33	2	36	S	72 19 15	W

Names of Places.	Sea or Country	Latitude.			Longitude.			High Wat. h
		°	'	"	°	'	"	
Van Dieman's Road	Tonga Tabu	—	21	4 15 S	174	56	24 W	
Vannes	France	—	47	39 14 N	2	46	26 W	
Vence	France	—	43	41 16 N	7	7	28 E	
Venice	Italy	—	45	26 0 N	12	4	30 E	
Venus (Point)	Otaheite	—	17	29 17 S	149	35	45 W	10 38
Vera Cruz	Mexico	—	19	12 0 N	97	30	0 W	
Verd (Cape)	Negroland	—	14	45 0 N	17	33	0 W	
Verdun	France	—	49	9 25 N	5	22	50 E	
Verona	Italy	—	45	26 26 N	11	18	30 E	
Verfailes	France	—	48	48 18 N	2	7	10 E	
Vienna (Observ.)	Hungary	—	48	12 40 N	16	22	30 E	
Vigo	Spain	—	42	14 24 N	8	28	0 W	
Vincent St. (Cape)	Spain	—	37	2 0 N	9	2	0 W	
Vintimiglia	Italy	—	43	53 20 N	7	37	30 W	
Virgin Gorda (Fort)	West Indius	—	18	18 0 N	64	0	0 W	
Virgin (Cape)	Patagonia	—	52	23 0 S	67	54	0 E	
Viviers	France	—	44	28 54 N	4	41	22 E	
Vutzburg	Franconia	—	49	46 0 N	10	13	45 E	
Wakefield	England	—	51	41 0 N	1	33	30 W	
Pr. of Wale's Ft	New Wales	—	58	47 30 N	94	7	30 W	
Wanstead	England	—	51	34 10 N	0	2	30 E	
Wardhus	Lapland	—	70	22 36 N	31	6	45 E	
Warsaw	Poland	—	52	14 0 N	21	0	30 E	
Westman (Isles)	North Ocean	—	63	20 30 N	20	27	45 W	
Whitsuntide (Isle)	Pacific Ocean	—	15	44 20 S	168	20	15 E	
William (Fort)	Bengal	—	22	34 45 N	88	29	30 E	
Willis's (Isles)	South Georgia	—	54	0 0 S	38	29	40 W	
Wilna	Poland	—	54	41 0 N	25	27	30 E	
Wittenburg	Germany	—	51	49 0 N	10	41	30 E	
Wologda	Russia	—	59	19 0 N				
Worcester	England	—	52	9 30 N	2	0	15 W	
Woslak	Russia	—	61	15 0 N				
Ylo	Peru	—	17	36 15 S	71	13	0 W	
York	England	—	53	59 0 N	1	6	40 W	
York (New)	Jersey	—	40	43 0 N	74	9	45 W	3 0
Yorkminster	Terra del Fuego	—	55	26 20 S	70	8	0 W	

C H A P. III.

Concerning the True FIGURE, and MAGNITUDE of the EARTH, with the Proportion of LAND and WATER, on its SURFACE.

IT appears necessary to say something concerning the *true FIGURE* of the EARTH; for though the Form of it be very nearly *spherical* or *globular*, yet it is not really so, but is of that Figure which is produced by a *Semi-ellipsis*, revolving about its *shortest Diameter*; and which is usually called an *Oblate Spheroid*; so that it is to be understood from hence, that the *Axis* of the Earth is less, or shorter, than the *Diameter* of the EQUATOR, whereas in a *Globe*, all the *Diameters* are equal.

As the *true FIGURE* of the EARTH is the very FIRST PRINCIPLE of GEOGRAPHY, so as an Article of SCIENCE, it is fit the young Student should have proper Ideas of it, especially as in former Ages it was not known at all; and in the present Century it has been so compleatly discovered as to have left scarce a Possibility of Improvement therein by any of our *Posterity*. It is also necessary to exhibit an Idea of the proper *Figure of the Earth*, to prevent any wrong Conclusions from a constant View of the *Terrestrial Globe* in a true *spherical Figure*. To these we may add the very interesting Consequences of knowing the real Figure of the Land and Sea, for perfecting the Sciences of *Geodesia*, *Astronomy*, and *Navigation*, as they are intimately connected therewith.

It is very surprizing to consider how universally all the Ancients supposed the Earth to be only a *plain Surface of Land and Water*, extended every Way indefinitely; a Form which common Sense revolts against on every Account; for (1.) The *globular Figure* of the *Ocean* presents itself notoriously to the View of every Person upon the Sea-Beach. (2.) The *gradual Disappearance* of all Objects on the Sea, as they are viewed from the Shore; as first the *Hull of a Ship*, then the *Masts*; and lastly, the *Streamers* and *Pennants*; whereas, if the Ship moved on a plain Surface, all Parts would become indistinct and vanish from the Sight at once, and that at a vastly greater Distance than where the Ship disappears. (3.) The same thing is observed of Objects on Land by the *Sailors* at SEA, in their *gradual Loaming*, *Disappearing*, &c. (4.)

(4.) The *Section of the Earth's Shadow* on the Surface of the Moon in a *Lunar Eclipse*, being *circular*, plainly proves it must proceed from a Body of a *globular Form*. (5.) The *Distance of two Hundred Million of Miles* on a *plain Surface*, would cause no sensible Alteration in the *Height of a Star*, as we know by the *North Pole Star* being of the same Altitude in the 20th of *June* and *December*; whereas if you go but $69\frac{1}{2}$ Miles on the *Meridian* of the EARTH, you alter the Star's Altitude *one whole Degree*; an indisputable Proof of the Earth's *Rotundity* or *spherical Figure*. How these, and many other *obvious and natural Demonstrations* of the Earth's *Figure* could escape the Notice not only of the *Vulgar*, but even the *Sages of ancient Times*, is equally amazing, as it is perfectly ridiculous to make the *Earth's true Figure* (much more the *false one*) an *Article of Faith necessary to Salvation* by the *Decrees of modern Councils*.

The *physical CAUSE* which produces a Figure of the Earth a little different from that of a SPHERE or *perfect GLOBE*, is the *Centrifugal FORCE* arising from the great Velocity of the Parts of the Earth about the *Axis of Motion*; it is the same Force which a Stone in a Sling is known to acquire by being swiftly whirled round in a circular Manner, and by which it has a strong Endeavour to recede or *fly* from the *Hand, or Center of Motion*.

Just so all the Parts of the Earth endeavour to fly off from the Axis of Motion, and would actually do so if they were not kept together by a far superior Force, viz. that of GRAVITY; by which they constantly *tend towards the Earth's Center*, and is therefore called the *Centripetal FORCE*.

When a strong and a weak Force act against each other, the Effect of the former will be lessened by the latter; and as the *Centrifugal Force* is greatest in Parts about the Equator, where the *Distance* from the Axis is greatest of all, so the Force of Gravity will there be most of all abated by it, and consequently all those Parts *receded farther from the Center* when the Earth was first put into Motion; and all the Parts of the Earth being connected by a *mutual Cohesion*, as the *Equatoreal Parts* receded, the *Polar Parts* would *accede towards the Center*; and so the extreme Parts of the Earth must indue a *Figure or Shape* somewhat different from that of a *Globe or Sphere*, that is, it must be a SPHEROID.

From several Measures of a Degree in the different Parts of the Meridian, and by Calculation it is found, that the Ratio
of

of the *Axis of the Earth* to a *Diameter of the Equator* is as 1019 to 1024. And it is from thence also found, that the *Axis of the Earth* is 7932 Miles, and a *Diameter of the Equator* 7971, which therefore exceeds the *Axis* by 39 Miles.

By Calculation it is also found, that a Degree at the Pole exceeds a Degree at the Equator a little more than an *English Mile*, and that a Degree of the Meridian in the Parallel of $54^{\circ} 44'$ is equal to a Degree in the Equator, which exceeds the first Degree of the Meridian by $\frac{3}{4}$ of a Mile.

The DIAMETER of the Earth being 7933, the Square Miles contained in its Surface, will be 197706226; and its solid context in Cubic Miles, will be upwards of 26139500000, or near 26140 Millions.

Our EARTH is called the *Terraqueous GLOBE*, because its Surface consists of LAND and WATER. As the LAND appears in very unequal and irregular Parcels, under the Names of *Continents, Islands, Capes, Isthmus, &c.* and the same may be said of the WATER, the Method of estimating the Quantity of each will appear by cutting out the several Parts of Land and Water from the Papers which cover the Terrestrial Globe, and weighing them separately in an exact Ballance; this was done about eighteen Years since, by Mr. MARTIN, from the Papers of a Terrestrial Globe, twenty eight Inches Diameter, when he found the Part for the Land weighed 367 Grains: ditto for the Aqueous Surface, 1125 Grains, and as the Surfaces must be in Proportion to their Weight, the Surface of the Water is to that of Land, as 3 to 1 nearly, or the Land is $\frac{1}{4}$ of the Earth's Surface only.

This Distribution and Proportion of Land and Water, is a most signal Instance of the WISDOM of GOD in the WORKS of CREATION. For thus the EARTH is rendered a fit Habitation for *rational social, and Commercial Agents*; the Oceans and Seas affording a free Intercourse between the most distant nations; at the same Time that they supply a just Quantity of VAPOURS, for the Formation of CLOUDS, to water the Surface of the Earth, for the Purposes of every Species of LIFE and VEGETATION that the infinitely wise AUTHOR of NATURE has made necessary.

C H A P. IV.

A DESCRIPTION and Use of the IMPROVEMENTS made to the New TERRESTRIAL and CELESTIAL GLOBES, by G. WRIGHT.

SINCE the New Discoveries made of late years by the celebrated CAPTAIN COOK, and other *eminent Navigators*, in the South Seas, (all which are accurately laid on the New Globes) I have contrived a very simple, easy, and expeditious method of *elevating the South Pole*, by which means the *New Discoveries, Tracks, &c.* may be clearly traced by the eye over all parts of the Globe, in a manner much more conspicuous and easy than Maps will admit of.

The new Improvements likewise consists in the following particulars, viz. 1st, there is engraved on the Globes two Hour Circles, one at the North, and the other at the South Pole, which are divided into twice XII Hours, and numbered round from East to West and contrary with a double row of Figures, the Meridian of London passing through both the XII Hours;* 2d, the hour Hand or Index 1 placed under the Brass Meridian, is moveable at pleasure to any part of the Hour Circle required, and will remain there during the revolution of the Globe on its axis, being entirely independant of the Poles on which the Globe moves. 3d, The divisions being placed in the Centre of the two rows of Figures, the Brass Index at once points out the time, and its complement to XII; this will be found exceeding useful and ready, in all Problems, where time is concerned, as at one view you have both the time of the rising and setting of the Sun, Moon, Planets, Stars, &c. on the Celestial Globe, and also the time that all places on the Terrestrial Globe, enter the illuminated and dark Hemisphere at Sun rising and setting, when it is made use of as a Tellurian; which it is immediately converted into by the Addition I have made of a Brass Semi-circle, moveable on the East and West Points of the Paper

* Plate the first is an exact representation of the two Hour Circles at the North and South Pole of the Terrestrial Globe, and fig. A of the Hour Hand or Brass Index to point out the Time on the Globes.

Horizon. Underneath the top Part, of which is fastened a thin Brass Spring, that presses against the outside of the Brass Meridian, so as to keep it always in its Place, when set to the Sun's Declination, on either Side the North Pole of the Globe; and for which Purpose, the Face of the Brass Meridian is divided on the outside, to 23 Degrees and half from the Pole upwards for South Declination, and downwards for North ditto. 4th, To make Use of the Globe as a Tellurian, observe the following general Directions to rectify it: first find the Sun's Declination N. or S. for the given Day on the Horizon, (as directed to be done for any of the former Problems), then elevate the Brass Semi-circle to the Declination found, and let it there remain fixed; you then move the Globe up or down the Notches of the Frame, till you bring the Semi-circle into the Zenith, and make fast the Meridian by means of the Screw, that goes through the Brass Pedestal on which the Meridian rests. 5th, The Globe being thus rectified, let a lighted Candle be placed at a considerable Distance on the Table from the Globe, the height of the Horizon, and in the Plane of the Meridian, it will then exhibit all the Phænomena of the Natural Globe of the Earth for that Day, for now the Brass Semi-circle becomes the Solar Horizon, or Circle of Illumination*, and divides the whole into the *enlightened and dark Hemisphere*; therefore upon revolving the Globe about its Axis from West to East, it will appear, that all Places emerging out of the dark Hemisphere into the luminous one under the Western Part of the Semi-circle will see the Sun then *rising*; when they arrive at the Meridian, it will be *Noon*; and when they descend into the dark Hemisphere at the Eastern part of the Semi-circle, they will see the *Sun set*.

When any place is upon the Meridian, set the Hour-Index to XII, and revolve the Globe, then you will see the natural Motion and Position of that Place at all hours of the Day; at what time the Sun rises or sets to it; the length of the

* I call it the Circle of Illumination. as you may conceive it to pass over the whole Globe, which it would do if the Globe was mounted on a Pedestal for that Purpose only, and had no wooden Horizon or Frame for common Use, (this would cost double the Money, and be of no other use than a Tellurian), as may be seen by placing the Horizon of the Globe perpendicular, and the Pole elevated to the Sun's Declination from the wooden Horizon, which by this means is made the Solar Horizon.

diurnal and nocturnal arches, or of DAY and NIGHT ; in what places the Sun does not rise or set at all ; whence all the variety of SEASONS through the year in every Climate, &c. &c.

6th, For the use of the Celestial Globe, there is given a copper-plate impresson on paper, of the Sun, Moon, and all the Planets, with their characters engraved within a small circle, which may be cut out at pleasure with a pair of scissars, (and being properly prepared) will by breathing on, or slightly touching them with the tongue, stick on to the globes, instead of wafers and black patches ; as commonly used, they are moveable at any time with your finger nail, or the point of a knife, &c. without injuring the Globe.

N. B. The Addition of the Brass Semi-circle, to the 9 and 12 Inch Globes, is only Three Shillings extra ; without it you have the Globes at the same Prices that common mounted Globes are sold for.

C H A P. V.

The DESCRIPTION and Use of a New PLANETARIUM, and MANUAL ORRERY, with considerable Improvements, by G. WRIGHT.

THE Price of *Orreries* (as they have been usually made) being very great, is one Reason why this *most useful* MACHINE is not so common, as one might wish, on Account of its great Service in conveying an easy and adequate Idea of the *true* CONSTITUTION of the SYSTEM of the WORLD, and, of Course, the First PRINCIPLES of ASTRONOMY and GEOGRAPHY although so essential a Part of *Education*. In order to remove this Difficulty, I have contrived a PLANETARIUM or ORRERY, at a moderate Price with Wheel Work, and another where the Planets are set by Hand only, which I call the MANUAL ORRERY, at a low Price ; either of which will readily shew what is, and what is not the true System of the World, with its various *Phænomena*, or Appearances of DAY and NIGHT, Vicissitude of the SEASONS, Nature of ECLIPSES, &c. as will be easy to apprehend from an Account of its Structure and various Uses, as follows.

I. This

I. This Machine is made to represent the **Ptolemaic System*, or such as is vulgarly received, which places the Earth in the Center, and the Planets and Sun revolving about it. And at the same Time affords a *most manifest Confutation* of it. For you plainly see, in this Construction, (1.) That the Planets *Mercury* and *Venus*, being both *within the Orbit of the Sun*, cannot be seen at any Time to go behind it; whereas we observe them as often to go behind, as before the Sun, in the Heavens. (2.) It shews, that as the Planets move in *Circular Orbits* about the Central Earth, they ought at all Times to be of the *same apparent Magnitude*; whereas, on the contrary, we observe their apparent Magnitude in the Heavens to be very variable, and so far different, that (for Instance) *Mars* will sometimes appear as big as *Jupiter* nearly, and at other Times you will scarce know him from a *fixed Star*. (3.) It shews that any of the Planets might be *seen at all Distances* (from the Sun) in the Heavens, or, in other Words, that when the Sun is setting, *Mercury* or *Venus* may be seen not only in the *South*, but even in the *East*; which Things were never yet observed. (4.) You see by the *Planetarium*, that the Motions of the Planets should always be *regular* and *uniformly the same*; whereas, on the contrary, we observe them always to move with a variable Velocity; sometimes *faster*, then *slower*, and sometimes *not at all*. (5.) By the Machine with Wheel Work, you see the Planets move all the *same Way*, viz. from *West* to *East* continually. But in the Heavens we see them move sometimes *direct* from *West* to *East*; sometimes *Retrograde*, from *East* to *West*, and at other Times to be *Stationary*. All which *Phænomena* plainly prove this System to be a *false and absurd Hypothesis*.

II. The Truth of the *Copernican*,† or SOLAR SYSTEM of the WORLD, which places the Sun in the Center, and the Earth among the Planets, is hereby most clearly represented.

* So called from *Ptolemy*, a celebrated Astronomer of *Alexandria*, in *EGYPT* who died A. D. 147.

† So called from *NICHOLAS COPERNICUS*, a most learned ASTRONOMER of *Russia-Royal*, who revived this System (formerly taught by the School of *Pythagoras*) and proved the Truth of it beyond all Dispute, and to the entire Satisfaction of the Pope and Cardinals.

III. All the *Primary* PLANETS are here disposed about the Sun, and all the *Secondaries* or *Satellites*, about their *Primaries*, in such order as we see them in the Heavens. Again, you may here represent the System in two Parts, *viz.* of the *inferior Planets*, and of the *superior*; and then the true comparative Distances of each Planet from the Sun, and among themselves, may be seen; and many very curious Things observed, which depend thereon; as the true *Heliocentric*, and *Geocentric Places*, the *Parallatic Angle*, the *Elongation*, and the true Proportion of *Distance* from the Sun, &c. which are the very *Fundamentals* of ASTRONOMY; and are here known, as it were, by Inspection only.

IV. By this Machine, if made with Wheel Work, you at once see all the Planets in Motion about the Sun with the *same respective Velocities, and Periods of Revolution* which they have in the Heavens. The Work being calculated to a *Minute of Time, from the latest Discoveries.*

Thus	{	Mercury	}	at the Distance	{	of about	{	revolves in	{	87.	23.	16	
		Venus								6700000	224.	16.	49
		Earth								9300000	365.	6.	9
		Mars								14200000	686.	23.	27
		Jupiter								48600000	4332.	12.	20
		Saturn								89100000	10759.	6.	36
												And	

And here also the Great and General Law of the Planetary Motions may be observed, *viz.* *That every where the Squares of the Periodical Time are proportioned to the Cubes of the Distances respectively.*

V. You will see here a Demonstration of the *Earth's Motion* about the SUN, as well as those of the Rest of the Planets; for if the Earth were to be at Rest in the Heavens, then the Time between any two *Conjunctions* of the same Kind, or *Oppositions*, would be the same with the *Periodical Time* of the Planets, *viz.* 88 Days in *Mercury*, 225 in *Venus*, &c. Whereas you here observe, this Time instead of being 225 Days, is no less than 583 Days in *Venus*; occasioned by the Earth's moving in the mean Time about the Sun the same Way with the Planet. And this Space of 583 Days always passes between two like *Conjunctions* of *Venus* in the Heavens. Hence this most important Point of Astronomy is satisfactorily demonstrated.

VI. The *Diurnal Rotation* of the Earth about its Axis, and a *Demonstration of the Cause of the different Seasons of the Year, and different Lengths of Day and Night*, by its Annual Motion through the twelve Signs of the Ecliptic, is here first shewn by a Terrestrial Globe of one Inch and a Half Diameter, having on it the 24 Hour Lines or Meridians, (the first of which passes through London), also the Ecliptic Tropics, Artic and Antartic Circles, with the Equator divided into Degrees, and Time, and the four quarters of the World delineated on it; and being made with a hole through the Axis from the South to the North Pole, to fit on a Steel Arbor, it is by this means left free to turn with your hand, to shew the Earth's Diurnal Motion at all times; you have also the Annual Motion, and Parallelism of the Axis, which causes the North Pole to point or keep to one position in the Heavens, during its period round the Sun, by this motion of the Earth, you see the cause and difference in the length of days and nights, and in different Latitudes throughout the year, also all the vicissitudes of the seasons by inspection, having for this purpose placed a Brass Circle to the Pedestal on which this Globe moves, the bright part of which always faces the Sun, and equally divides the Globe in a natural Position, so as to shew the one half towards the Sun, always illuminated, whilst the other half from the Sun will be in the dark Hemisphere, and by giving it a diurnal motion with your Hand from West to East, you observe the reason
of

of day and night, as also the different lengths or quantity of the Diurnal and Nocturnal Arches, by the Time the City of LONDON (or any other Place) describes in the light and dark Hemispheres, at different Times of the Year, by setting the Globe to its proper Place in the Ecliptic according to the Day of the Month, with the Hand.

VII. As to the ECLIPSES of the *Sun* and *Moon*, the true Causes of them are here very clearly seen; for when the Moon is placed in a right Line between the Centers of the Sun and Earth, her *Shadow* (by Candle-light) will fall on the Earth, and all who live on that Part over which the Shadow passes will see the *Sun eclipsed* more or less. On the other Side, the Moon passes (in the aforesaid Case) through the *Shadow* of the *Earth*, and is by that Means *eclipsed*. And the Mechanism of the Orrery is such, that any one who has a Mind to do it, may easily represent the due POSITION and NODES of the *Moon's Orbit*; and thence shew when there will or will not be an *Eclipse* of *either Luminary*; and what the Quantity of each will be; but this Affair I leave to the Purchaser, as it will increase the Price.

VIII. While the Moon is moving about the Earth in the Center; if a *Candle*, or rather a *glass Lamp*, be placed at a proper Distance to enlighten the Earth and Moon, you will see all the Phases of the Moon, as *new*, *dichotomized*, *gibbous*, *full*, *waning*, &c. just as they appear in the Heavens. You will moreover observe all the same Phases of the Earth as they appear at the Moon.

IX. The SATELLITES of JUPITER and SATURN are moveable only by the Hand; yet may all their *Phænomena* be easily represented excepting the true relative Motions and Distances, thus: If that gilt *Globe* which before represented the SUN, be made now to denote *Jupiter*, and four of the Primary Planets only be retained, then will the *Jovian System* be represented; and by Candle-light you will see (the Machine being in Motion) the *Immersion*s and *Emersion*s of the Satellites into and out of *Jupiter's Shadow*. You will see plainly the Manner in which they *transit his Body*; and their *Occultations* behind it. You will observe the various Ways in which *one or more* of those Moons may at Times *disappear*. And if the Machine be set by a white Screen or Wall, &c. then, by the *Projection* of their *Shadows*, will be seen the Reasons why those Moons always appear on each Side

Side *Jupiter* in a *Right Line*: why those which are *most remote* may appear *nearest*, and *è contrario*. And the same may be done for *Saturn's Five Moons*, and his *Ring*. And the Expence would be but trifling to have Arms of a proper Length for the true Proportional Distances of the Satellites.

X. The Machine is not only ornamented, but rendered more generally useful, by the Plate Mr. MARTIN some Years ago published under the Title of *SYNOPSIS SCIENTIA COELESTIS*;* which is here made the Basis of the Orrery, having the *SOLAR SYSTEM* in the Center? the *Earth* in eight different Positions about the *Sun*; the *Circular CALENDAR* of *MONTHS* and *DAYS* for the *Old* and *New Stile*; over which the Planets move, and by which their Motions may be compared and estimated. Then follow various Astronomical Circles, viz. *Right Ascension*, *Declination*, *Amplitude*, *Equation*, *of Time*, *Twilight*, *Phases of Saturn's Ring* during his whole Period, &c. with their several Uses in the Sphere, all in one View; and, lastly, a large and beautiful *ECLIPTIC* of the *Twelve SIGNS* here makes the *Solar Horizon*, wherein the Place of the *Sun*, and *Heliocentric Places* of all the Planets are at any Time to be shewn.

XI. Lastly, That *Grand Phænomenon*, the *Revolution* of the *Pole of the World* about the *Pole of the Ecliptic* in a retrograde Manner, in the Space of 25920 Years, may here also be represented, and, of Course, the *Recession* of the *Equinoctial Points*, the *Motion* of the *Stars* apparently forward through all the Degrees of the *Ecliptic*; the *Anticipation* or *Procession* of the *Equinoctial Days*, and the *Mutation of Seasons* through all the Calendar, with many other Particulars, will by this Means be shewn, and the *Rationale* of those otherwise mysterious Subjects will evidently appear. This is an additional expence, but may be added if required.

But as neither Orrery or Planetarium may be in the Possession of many Persons, that wishes a fuller Illustration of the *Ptolemaic* and *Capernican Systems*, than can possibly be shewn by Circles drawn on Paper only. I have, in Addition to the

* Note, this Print to be had separate, price 3s. also the *Wonders of the Cometary World*, price 2s. and 6d.

Solar System, Plate 3d, given an Ecliptic with the twelve Signs and Months, Points of the Compass, &c. divided in the same manner as is done for the Horizons of the Globes; by this Means, a Portable Manual Orrery is made at a very small Expence, as you have only to procure a Piece of Pasted-Board, or thin Deal Board about the Size of the Print, which is to be taken from out the Book, and pasted on the Board. Plate 4th contains the five Primary Planets with the Earth, printed on fine Pastedboard, the shaded or dark Parts of the Circles which represents the Planets, will shew that in their revolution round the Sun, one half only can be illuminated, the length of the Arms for each Planet, are by no means agreeable to their Distances from the Center to their Orbits, that is not regarded in large and expensive Orrerys, as may be seen by the Solar System in the Plate; the Arms and Planets must each be cut out separate with a Pair of Scissars, and then let a strong Pin be put through the Center Point, at the end of each Arm, and fixed in the Center of the Solar System, *Saturn* being placed first or next the Board, *Jupiter* next, and so on in rotation to *Mercury*; then set them to their respective Places in the Ecliptic by the help of an Ephemeris, the same as you would do for any other Orrery, which done, let a Pin be stuck through the Center of each Planet, and it will shew their Situations as exact as can be done by any other Manual Orrery, and being moveable with ease it answers nearly every Purpose that an Orrery without Wheel-Work can do.

The Heads of the Pins being small, will admit of your placing them in their different Planes or Latitudes. And if the Heads were made with small Beads, or enamelled and of different Diameters, it would be still more natural, and a Gilt Headed Pin for the Center, to represent the Sun, and another with Ivory, and Lines drawn on it for the Earth, when you represent the Ptolemaic System.

Note, The whole may be had compleat with the Print properly pasted, coloured and varnished, and separate from the Book if required.

As also one on a larger Scale, being in Diameter just sufficient to go within side the Horizon of a 12 Inch Globe, and

and is made to lodge nearly on the Plane of the Horizon. This is most convenient for any Person that has a Globe or Globes of this Size; for, by loosening the Screw of the Pedestal on which the Meridian turn, the Globe may be taken out of its Frame, and the Orrery put in its Place, by this Means you will have an exceeding good manual Orrery, that will shew you as much as those usually sold for £2. 12s. 6d. or three Guineas.

C H A P. II.

A short ACCOUNT of the SOLAR or COPERNICAN SYSTEM.

HAVING shewn in the Use of the Orrery, that the Ptolemaic System will not solve the Appearances of the Heavens, and that the Copernican System is the only true one, we now take a Survey of the Solar System, and shew how elegantly all the Phænomena before observed, are illustrated by this System; which is represented Pl. III. where the Orbits of the respective Planets are distinguished by their Characters. The Orbits of three Comets are also delineated, with the Years of their Appearances. In the right Corner are given the proportional Magnitudes of the Planets, the Sun being supposed equal to the Orb of Saturn, or about 6 Inches Diameter.—A, is Mercury; B, Venus; C, the Earth; D, Mars; E, Jupiter, with his Belts; F, Saturn with his Ring.

In the left Corner are given the proportional apparent Diameters of the Sun, as seen from the several Planets. Thus, supposing at Mercury the Sun appears as big as Fig. *a*; in Venus it would appear no bigger than *b*; at the Earth than *c*; at Mars *d*; at Jupiter *e*; and at Saturn *f*.

The Sun is the Central Body of this System, about which the Earth and other Planets revolve; the Moon round the Earth, 4 Moons or Satellites round Jupiter, and 5 round Saturn and his Ring.

The Sun is in Diameter 895000 Miles, and turns on its Axis in 25^d, 15^h, 16^l.

The Magnitudes, Distances of the Planets from the Sun, &c. are expressed in the annexed Table.

O

Planets

Planets.	Mean Distans	Mean Dist. in English Miles.	Diameters in English Miles.	Proportional Magn.	M. Velocity per Minute.	Periodic. Times
						D. H. ' "
♂ Mercury	38710	36155000	1806,5	135,69	1793,7	87,23,14,34
♀ Venus	73333	67558650	5988,7	4272,3	1310,14	224,16,41,30
☉ Earth	100000	93399590	7951,4	10000.	1117,1	365,05,49,25
♂ Mars	152369	142312000	3952,64	1228,4	908,66	686,22,18,19
♃ Jupiter	520796	485767060	724326,	755415	471,02	4330,08,35,0
♄ Saturn	954006	891038000	57461	3774014	359,98	10750,13,14,42

The principal Phenomenon relating to the Sun and Planets, are the following :

1. That the Sun appears to have an annual Motion round the Earth. This is caused by the real annual Motion of the Earth round the Sun.

2. The Sun as well as the Planets and Stars, appears to move daily round the Earth from East to West every Day. This is caused by the real diurnal Motion of the Earth round its Axis from West to East.

3. The Times of the Revolutions of the Planets round their Axes are discovered by their Maculæ or Spots : And by the Paths these Spots appear to describe over the Disk of the Sun or Planet, the Inclinations of their Orbits are determined.

4. Mercury is the nearest Planet to the Sun, and we find in this System, that its Motions are agreeable to what really happens in the Heavens.

5. As it has two Conjunctions, an inferior and superior, it follows, that the Orbit of this Planet, must be within the Orbit of the Earth, and its greatest Elongation (or Distance it is seen from the Sun) being but 28 Degrees, whereas Venus's is 47°, shews it to be within the Orbit of Venus.

6. As this Planet never appears far from the Sun, it is but seldom seen,—From the Time of his inferior to his superior Conjunction, he rises and sets before the Sun, and therefore will be seen only in the Morning. But from his superior to his inferior Conjunction, he will rise and set after the Sun, and then can be seen only in the Evening.

7. Venus the next Planet in the System, being also an inferior

ferior Planet, has in general the same Phenomena as Mercury.

8. When Venus is Westward of the Sun, she rises and sets before him ; therefore can only be seen in the Morning, and when to the Eastward of the Sun, in the Evening.

9. Venus has Phases like our Moon. These were first observed by Galileo with his Telescope.

10. She appears in her greatest Lustre when she is removed from the Sun about 40 Degrees, before and after her inferior Conjunction, though only one-fourth of her illuminated Face is then turned towards the Earth.

11. Of the Earth, the apparent Motion of the Sun and Stars round the Earth every 24 Hours, is caused by the real diurnal Motion of the Earth round its Axis.

12. If the Axis of the Earth was not inclined to that of the Ecliptic, the Days and Nights would always be equal, to all Parts of the Earth : But as the Axis of the Earth is inclined to the Ecliptic $23^{\circ} 28'$ and does in the annual Motion of the Earth preserve its Parallelism, it readily accounts for the different Lengths of Days and Nights, Summer and Winter.

13. The Time from the Sun's being on the Meridian of any Place, and its next appearing on the same Meridian, or a Day, being called 24 Hours, solar Time ; the Time elapsed between the coming of a Fixed Star to the Meridian of any Place, and its appearing again on the same Meridian ; or which is the same thing, the Time the Earth takes to revolve round its Axis, is $23^{\circ}, 56', 54''$, is called Siderial Time ; the Difference is $3', 54''$, daily.

Hence we know the best Method of regulating Clocks is to equal or siderial Time.

14. *Mars* is the first superior Planet, or which lies beyond the Earth's Orbit ; Venus and Mercury being inferior or within it.

15. It has been already observed in the Use of the Orrery, that all the Planets move sometimes direct, sometimes retrograde, sometimes are stationary.—At different times are at different Distances, and therefore appear of very different Magnitudes.

16. A superior Planet hath only one Conjunction, which is a superior one, whereas an inferior Planet hath two.

17. A superior Planet hath an Opposition, but an inferior hath none.

18. As

18. As we observe the Phenomena of Mars to be agreeable to the Motions of a superior, but not of an inferior, it appears, that Mars must be a superior Planet.

19. When Mars is in Conjunction its Face is enlightened like our full Moon, and would appear so, if it did not become invisible, by being in the same Direction as the Sun. At any other Time it appears more than $\frac{1}{2}$ enlightened, or gibbous, resembling our Moon a few Days before or after the Full.

20. Jupiter and Saturn being superior Planets, their Motion must be similar to those of Mars, and therefore, need not be particularly described.

21. The Moon is in Diameter about 2175 Miles; and is at its mean Distance about $60\frac{1}{3}$ Semidiameters of the Earth, from the Earth; its greatest being $64\frac{2}{3}$, and least $55\frac{1}{3}$.

22. The Time the Moon requires to perform its annual Revolution in its Orbit (with respect to the Stars) is $27^{\circ}, 7^h, 43'$, called a *periodical Month*. But as in this Time, the Earth has proceeded forward some Degrees in its annual Course, the Time from one Conjunction to another, called a *synodical Month*, must be somewhat longer, viz. $29^{\circ}, 12^h, 44'$. So that the Moon makes about 13 Revolutions round the Earth in a Year, or there are 13 periodical Months; whereas there are but 12 synodical ones.

23. The Inclination of the Moon's Orbit to the Plane of the Ecliptic, is about $5\frac{1}{4}$ Degrees.

24. The Moon's Node has a retrograde Motion, making a Revolution with respect to the first Point of Aries, in 18 Years, 224 Days, 5 Hours.

25. The Moon is about 300 Times nearer the Earth than the Sun.

26. The Moon's true Diameter, according to Observations, is to that of the Earth as 3 to $11\frac{1}{7}$; hence the Earth must give about 13 Times as much Light to the Moon, as the Moon does to the Earth. And their Solidities are as 27 to 1384, or as 1 to $81\frac{1}{7}$.

27. It may be observed, that the Moon always keeps the same Face towards the Earth, and therefore must turn round its Axis, in the same Time as it performs its Revolution in its Orbit, viz. in $27^d, 7^h, 43'$.

28. The Phases of the Moon prove that she shines by reflected Light of the Sun, and not by any Light of her own.

27. The

29. The Moon's Path in absolute Space, is every where Concave towards the Sun.

30. An *Eclipse* of the *Moon* is caused by an Interposition of the Earth between the Sun and Moon, thereby intercepting the Rays of the Sun from falling on the Moon, and therefore can only be at full Moon.

31. If the Opposition be near a Node, the Eclipse may be total; if at more remote Distances, only partial.—When the Opposition falls more than 12 Degrees from a Node there will be no Eclipse, the Earth's Shadow then either passing above or below the Moon. This shews the Reason why we have not an Eclipse every full Moon.

32. An Eclipse of the Moon appears of the same Quantity of Digits, at all Places where it is visible. And the Difference of Longitude of Places are easily determined, by comparing Observations of the Beginning or End, taken at the Places whose Difference of Longitude is required; for the Difference of observed Time, turned into Degrees, by allowing 15 Degrees to an Hour, will be the Difference of Longitude required: The Eclipse beginning sooner to the Westermost Place, and later at the Eastermost.

33. An Eclipse of the Moon begins on the East Side, and ends on the West.

34. From an Eclipse of the Moon these Corollaries may be made.

Cor. 1st. It is manifest the Moon is an opaque or dark Body, for if it was luminous in itself, it could not be deprived of its Light by the Shadow of the Earth, (which is nothing but the Loss or Privation of the Light of the Solar Rays) any more than a Candle can lose its Luminousness, by being placed in the Shadow of any opaque Body.

Cor. 2. If the Earth was equal in Diameter with the Sun, the Earth's Shadow would be indefinitely extended, as it must every where continue of the same Breadth; and would be of a Magnitude more than sufficient to eclipse Mars, as it is less than the Earth. This is never the Case, therefore the Earth cannot be equal in Diameter to the Sun.

Cor. 3. As the Earth's Shadow never reaches Mars, being of a conical Figure, converging to a Point, before it reaches that Planet, it is evident, the Sun must be much greater than the Earth.

Cor. 4. As the Earth's Shadow, where the Moon passes
tho'

thro, it, is about three Times the Diameter of the Moon, it follows, that the Moon must be much less than the Earth.

Cor. 5. As the Earth's Shadow appears always circular on the Moon, it is an ocular Proof that the Earth is a Sphere or Globe, for otherwise its Shadow could not always be circular.

35. An *Eclipse* of the *Sun* is caused by the Interposition of the Moon between the Sun and Earth, and thereby hiding the Sun, either in Whole, or in Part.

36. Of Solar Eclipses there are three Kinds, viz. *partial*, *total*, and *annular*.

A *partial Eclipse*, is when the Moon passes between the Spectator's Eye in such Manner, as only to hide a Part of the Sun.--When the Center of the Moon is nearly in the same Direction as the Center of the Sun, if the Moon's apparent Magnitude be sufficient to hide all the Body of the Sun from the Spectator, such Eclipse is properly called *total*: But if the Moon is of less apparent Magnitude than the Sun, so that it only hides the middle Part of the Sun, leaving a Border or Ring of Light round it, the Eclipse is then said to be *annular*, which is a very rare Phænomenon.

37. Hence it appears, that what is commonly called an Eclipse of the Sun: For the Sun being luminous in itself, cannot be deprived of its Light by the Interposition of any any Body. Hence it is the Earth that is in Fact eclipsed, and not the Sun,

38. The Moon by its being interposed between the Sun and Earth, its Penumbra will eclipse some Parts of the Earth, and cause in its Appearance, an Eclipse of the Sun.

39. Hence it appears that an Eclipse of the Sun can only happen at a new Moon, and not every new Moon, but only when the Moon is in Conjunction with the Sun near a Node, viz. within 18 Degrees.

40. An Eclipse of the Sun differs from an Eclipse of the Moon in the following Particulars.

1st. We have already observed, that an Eclipse of the Sun is only an Appearance; whereas, that of the Moon is really an Eclipse.

2d. An Eclipse of the Sun begins on the West Side of the Limb. and ends on the East: But an Eclipse of the Moon begins on the East Side, and ends on the West.

3d. Lunar Eclipses are more frequent to any particular Place of the Earth than Solar; notwithstanding the Solar Limit

Limit is greater than the Lunar : Because, an Eclipse of the Moon appears the same from all Places of the Earth, as before observed ; whereas, there may be at one Time a total Eclipse of the Sun at one Place, partial at another, and at other Places no Eclipse at all.

41. If the Orbit of Mercury lay in the Plane of the Ecliptic, at every inferior Conjunction it would tranfit the Sun, and appear like a black Spot thereon.—But as the Orbit is inclined about 7 Degrees, and intersects the Ecliptic in $14^{\text{d}}, 43'$ of Taurus, and $14^{\text{d}}, 43'$ of Scorpio, called the ascending and descending Nodes, a Tranfit can only be when the inferior Conjunction happens in, or near, these Parts of the Ecliptic, and so can only happen on or near the 6th of November, or 4th of May.

42. As the ascending Node of Venus is in 14 Degrees of Gemini, and its opposite or descending Node in 14 Degrees of Sagittarius, Venus can never tranfit the Sun, but when the inferior Conjunction happens on, or about, the 5th of June, or 6th of December.

43. The first Tranfit of Venus which was observed, was calculated and seen by Mr. *Jeremiah Harrox*, a young Gentleman near Liverpool, in the Year 1639.

44. The 4 Moons or Satellites of Jupiter, were discovered by *Galileo* in the Year 1610.

45. Their Distances from Jupiter and Periodical Revolutions are given in the Table annexed.

Satellite	Dist. in Semid. of J	Periodic. Revolution		
		D	h	'
1	5.667	1	18	27
2	9.017	3	13	13
3	14.384	7	3	42
4	25.299	16	16	32

46. Jupiter's Moons must, like ours, appear sometimes gibbous, full, &c.

47. As the Moon is eclipsed by the Shadow of the Earth, so are the Moons of Jupiter by the Shadow of that Planet.

48. It

48. It is evident, that as these Moons have different Periods, they must in different Nights appear to us very differently posited; sometimes most on one Side, sometimes on another, &c. And sometimes those which are really nearest to Jupiter's Body, will to us appear more remote.

49. The first who observed a Satellite of Saturn was Mons. *Huygens*, who in the Year 1655 discovered one, viz. the fourth. As to the other four, they were discovered by *Cassini*.

50. Their Distances from Saturn and Periodical Times are as in the following Table.

Satellite	Distan. in Semidiamet of the Ring	Periodical Time. D h '
1	2.10	1 21 18
2	2.69	2 17 41
3	3.70	4 12 25
4	8.70	15 22 41
5	25.45	79 7 48

51. All these Satellites and their Eclipses, can only be seen by the Help of Telescopes, of very great magnifying Powers.

Their Phænomena are so nearly similar to those of Jupiter's Satellites, that nothing need be said on this Head.

52. Saturn's Ring is inclined to the Ecliptic about 30 Degrees, and is reckoned in Breadth about 21 thousand Miles.

53. The Ring goes through all its Appearances in about 14 Years.

54. Dr. *Clark's* Father, as Mr. *Whiston* says in his Memoirs of Dr. *Clark's* Life, saw a Star between the Ring and Body of the Planet.

55. It has long been discovered, that the Sun was not exactly in the Center of the several Orbits, though nearly so; and the sagacious *Kepler* found that the Orbits were really Ellipses, though very little different from Circles, and the Sun in their common Focus.

56. After *Kepler* came the most excellent Sir *Isaac Newton*. He has shewn that all Bodies have a Tendency towards each other;

other; which he calls *Gravity*, or *universal Attraction*. He indeed does not take upon him to determine what it is, whether it is caused by any particular Natural Agent, or by the immediate Hand of the Deity; but evidently shews the Existence of such a Thing; from whence he demonstrates.

57. 1st. That a Body being projected in the Direction of a right Line, and acted on continually by a Force tending to a Center, the Body or Planet so projected, must describe equal Areas in equal Times.

58. 2d. That every Body, that moves in a curve Line, described in a Plane, and by a Radius drawn to a Point, describes about that Point Areas proportional to the Times, is urged by a Force directed to that Point.

59. 3dly. It is demonstrated, that if a Body revolves in an Ellipsis, the Law of Centripetal Force tending to one of the Focus's, must be reciprocally as the Square of the Distance from the Focus: or Center of Attraction.

60. 4thly. And that a Circle, the attracting Power being in the Center, and an Ellipsis, the attracting Body being in one of the Focus's, are the only Curves that return into themselves, in which the Centripetal Force is in the inverse Ratio as the Square of the Distance.

61. For if the attracting Body was placed in the Center of the Ellipsis, the Law of Centripetal Force would be in the inverse Ratio of the Distance, and not of the Square of the Distance.

62. 5thly. That if several Bodies revolve about one common Center, with Centripetal Forces in the inverse Ratio of the Squares of the Distances; that then, the Squares of the periodic Times are as the Cubes of the Distances.

All these Propositions are strictly true, being mathematically demonstrated by the great Author in his Principia.

63. By the Observations of modern Astronomers, the Comets seem to move in Elliptic Orbits, and to be governed by the same Laws as the Motions of the Planets: Only in Orbits more eccentric.—Hence it follows, that in such Case, the Comets must have regular Periodical Returns like the Planets: But the Misfortune is, that most of the ancient Astronomers, and Astrologers, imagined Comets to be only Meteors, and fatal Presages of some great Evil to follow; and for that Reason never took any exact Astronomical Observations of their Motions; thinking it sufficient to say, that at such a Time, a Comet of such a Magnitude appeared in such

a Constellation of the Heavens, and after it such direful Events happened. For which Reason, as the periodical Returns of Comets consist of a large Number of Years, the Periods of very few have been determined. The first Comet which hath been observed, with a necessary Degree of Accuracy, was that of the Year 1577, by *Tycho Brake*.

64. The learned Dr. *Hally* in his Synopsis of the Astronomy of Comets, says, "There are many Things which make me believe that the Comet which *Apian* observed in the Year 1531, is the same with that which *Kepler* and *Lomontanus* more accurately described in the Year 1607; and which I myself have seen return, and observed in the Year 1682. All the Elements agree, and nothing seems to contradict this my Opinion besides the Inequality of the periodic Revolutions. Which Inequality is not so great neither, as that it may not be owing to Physical Causes. For the Motion of Saturn is so disturbed by the rest of the Planets, especially by Jupiter, that the periodic Time of that Planet is uncertain for some whole Days together.—How much more therefore will a Comet be subject to such like Errors, which raises almost four Times higher than Saturn, and whose Velocity, tho' increased but a very little, would be sufficient to change its Orbit to a parabolical one." He also remarks its being seen in the Year 1456; and the same Comet (as he thinks) was seen in the Year 1305, which is another double Period of 151 Years. Hence he ventured to foretell that it would return again in 1758; and it did actually return in the Beginning of the Year 1759, at which Time it was visible in many Parts of America; and observed to be, as Mr. *Turner* says, ascending back from the Center of the System.

Another Comet was observed in 1661, and is supposed will return again in about 575 Years, or about the Year 2255.

These are all whose Periods are as yet known.

65. The Number of Comets which have been observed are about 40.

66. The Nature of a Comet's Path was not known before Sir *Iaac Newton* applied himself to the Subject.

67. From the Motion of Comets it is evident the Celestial Spaces are void of Resistance. For though the Comets are carried in oblique Paths, and sometimes contrary to the Course of the Planets, yet they move every Way with the greatest Freedom, and preserve their Motions an exceeding long Time, even when contrary to the Course of the Planets;—Hence

—Hence the *Cassian* Doctrine of Vortices to carry the Planets round the Sun, is absurd.

68. The Opinion of some Writers that Comets are only Meteors, who have been led into this Opinion by the Changes that happened to their Heads, is without Foundation. For the Heads of Comets are encompassed with huge Atmospheres, and the lowermost Parts of these Atmospheres must be densest: And therefore it is in the Clouds only, and not in the Bodies or the Comets themselves that these Changes are seen. Thus also the Belts of Jupiter, as Sir *Isaac Newton* observes, are formed in the Clouds of that Planet.

69. Sir *Isaac Newton* computes, that the Comet of 1680, when in its Perihelion, must be heated by the Sun 2000 Times hotter than red-hot Iron. Hence it follows that the Bodies of Comets must be very solid, compact, fixt and durable, like the Bodies of the Planets, otherwise their Particles of Matter would fly off.

The greatest and most fulgent Tails always arise from Comets immediately after their passing by the Neighbourhood of the Sun. Therefore, the Heat received by the Comet conduces to the Greatness of the Tail. Hence we may infer, that the Tail is nothing but a very fine Vapour, which the Head, or Nucleus of the Comet, emits by its Heat.

We cannot end this short Account of the Solar System better, than observing, “ That this most beautiful System could only proceed from the Council and Dominion of an intelligent, powerful, wise, and good Being, whom we call GOD.

I.

The spacious Firmament on high,
With all the blue etherial Sky,
And spangled Heavens, a shining Frame,
Their great Original proclaim:
The unwearied Sun, from Day to Day,
Does his Creator's Pow'r display,
And publishes to every Land
The Works of an Almighty Hand.

II.

II.

Soon as the Ev'ning Shades prevail,
The Moon takes up the wondrous Tale,
And nightly to the listning Earth
Repeats the Story of her Birth:
Whilst all the Stars that round her burn,
And all the Planets in their Turn,
Confirm the Tidings as they roll,
And spread the Truth from Pole to Pole.

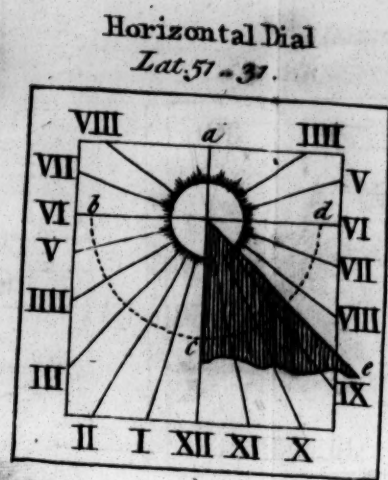
III.

What though, in solemn silence, all?
Move round the dark terrestrial Ball?
What tho' nor real Voice nor Sound,
Amid their radiant Orbs be found?
In Reason's Ear they all rejoice,
And utter forth a glorious Voice,
For ever singing, as they shine,
"The Hand that made us is divine."

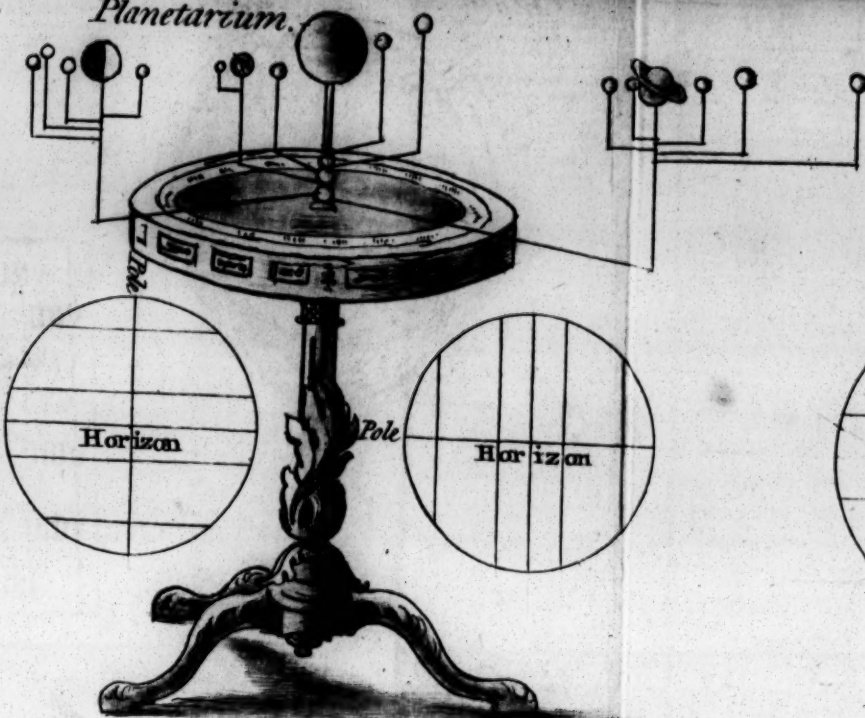
SPECTATOR, Vol. VI. N^o 465.



PLATE II. *Globe.*



Planetarium.



Armillary Sphere.

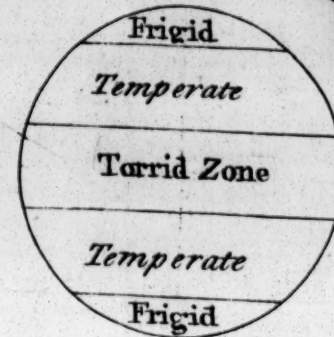
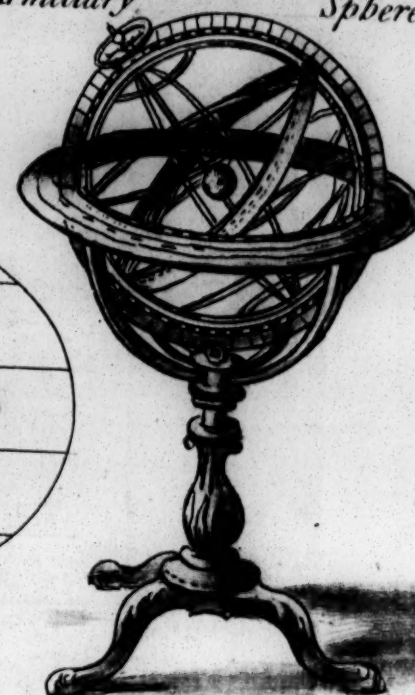
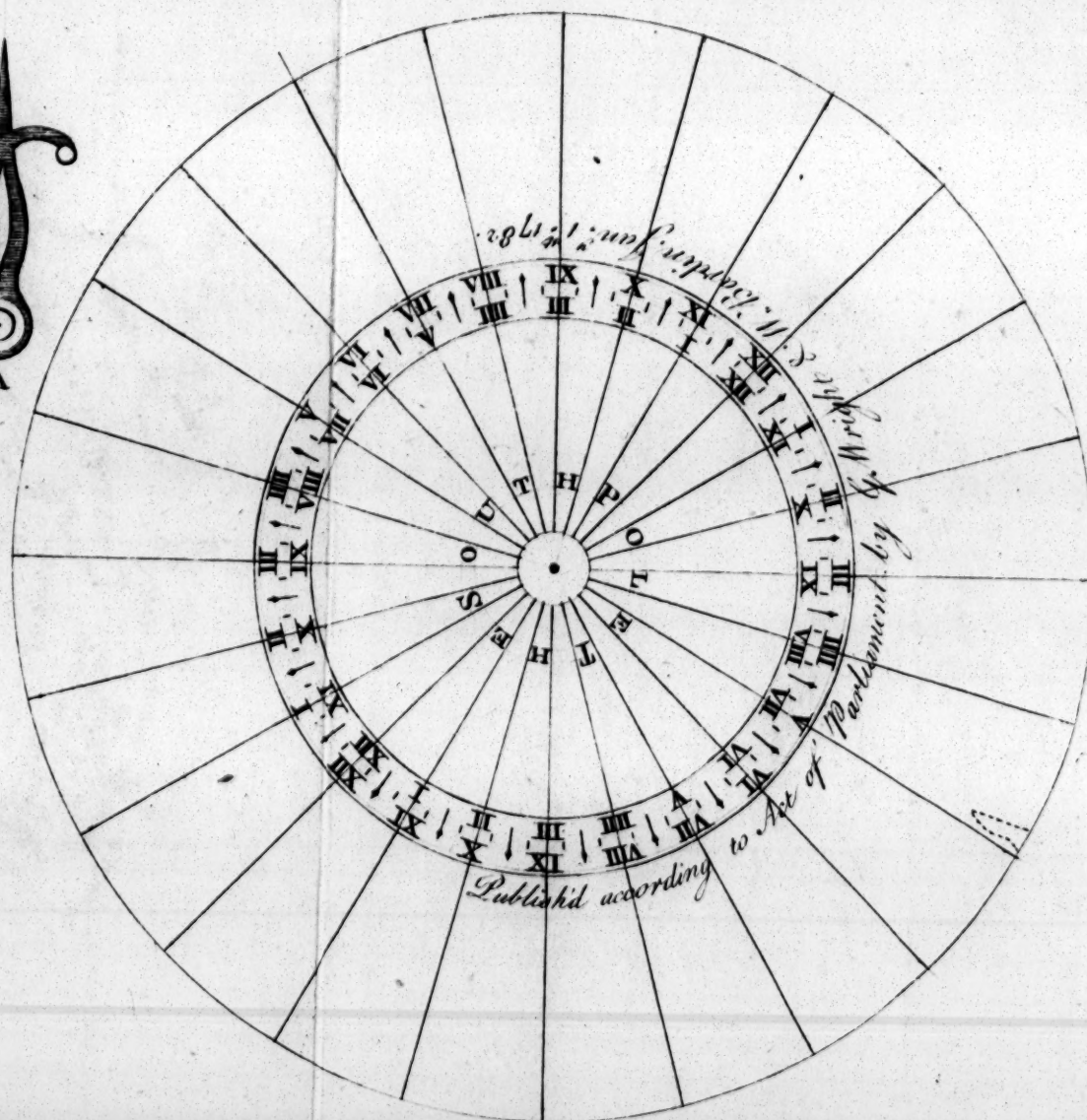
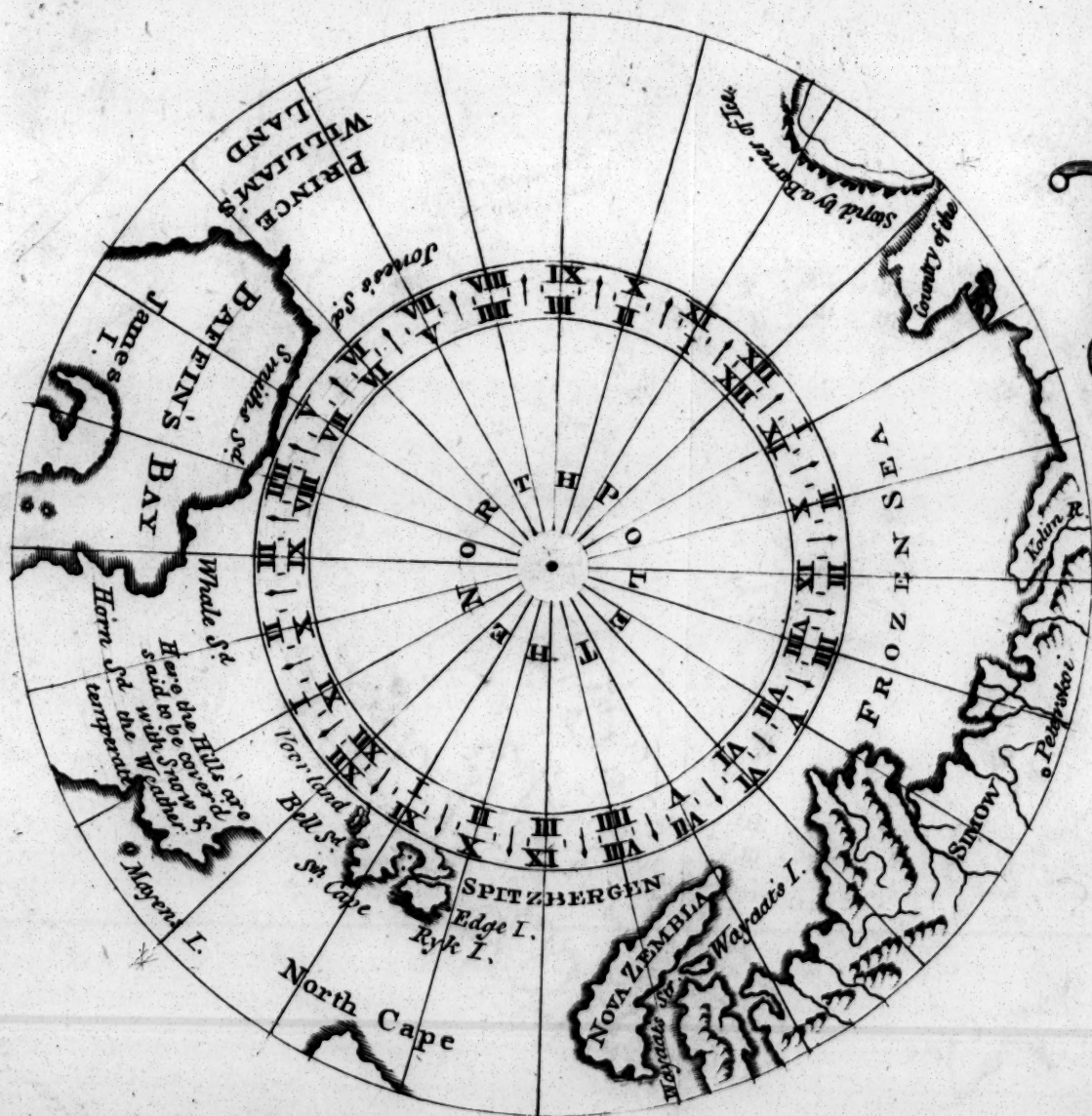
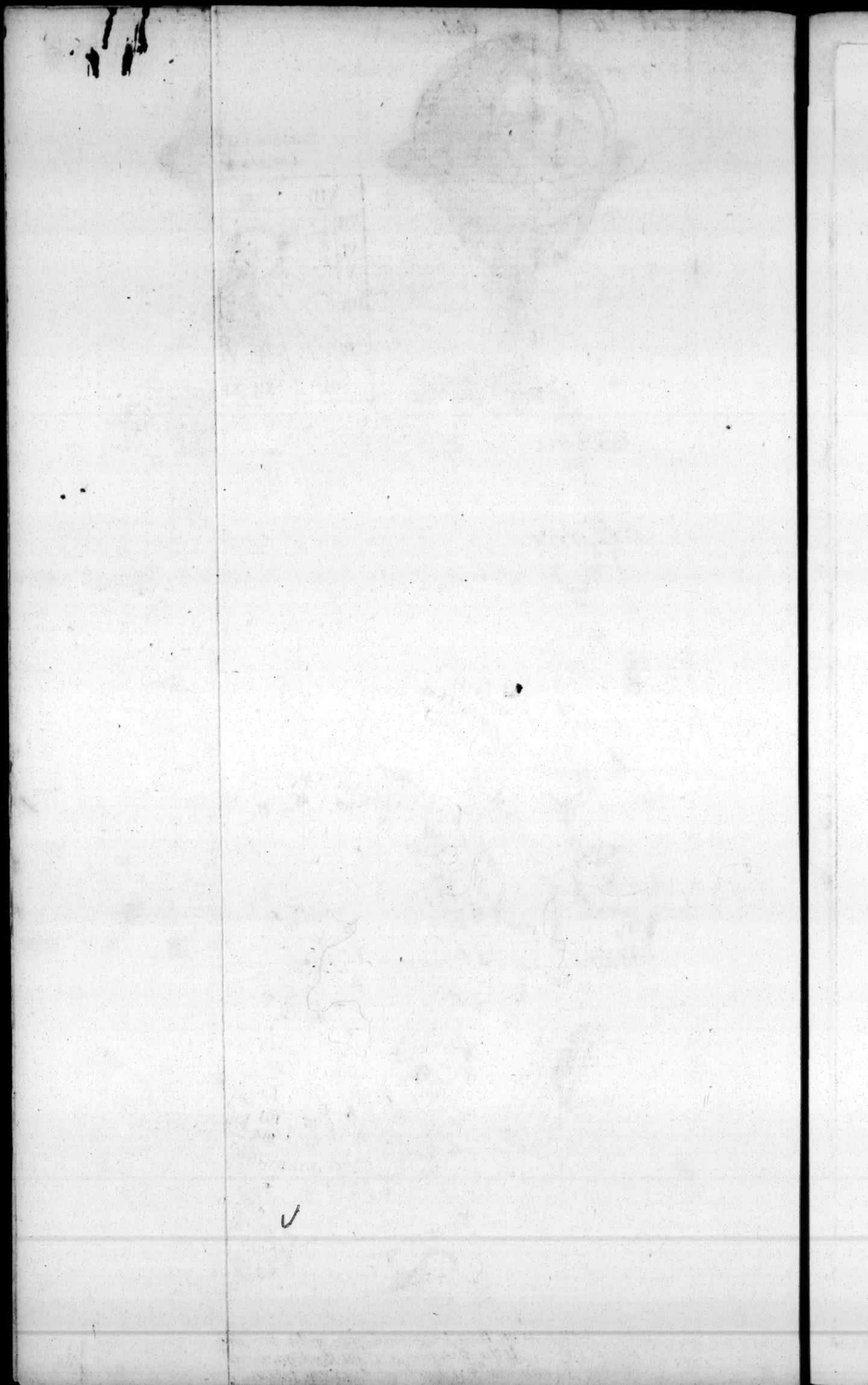
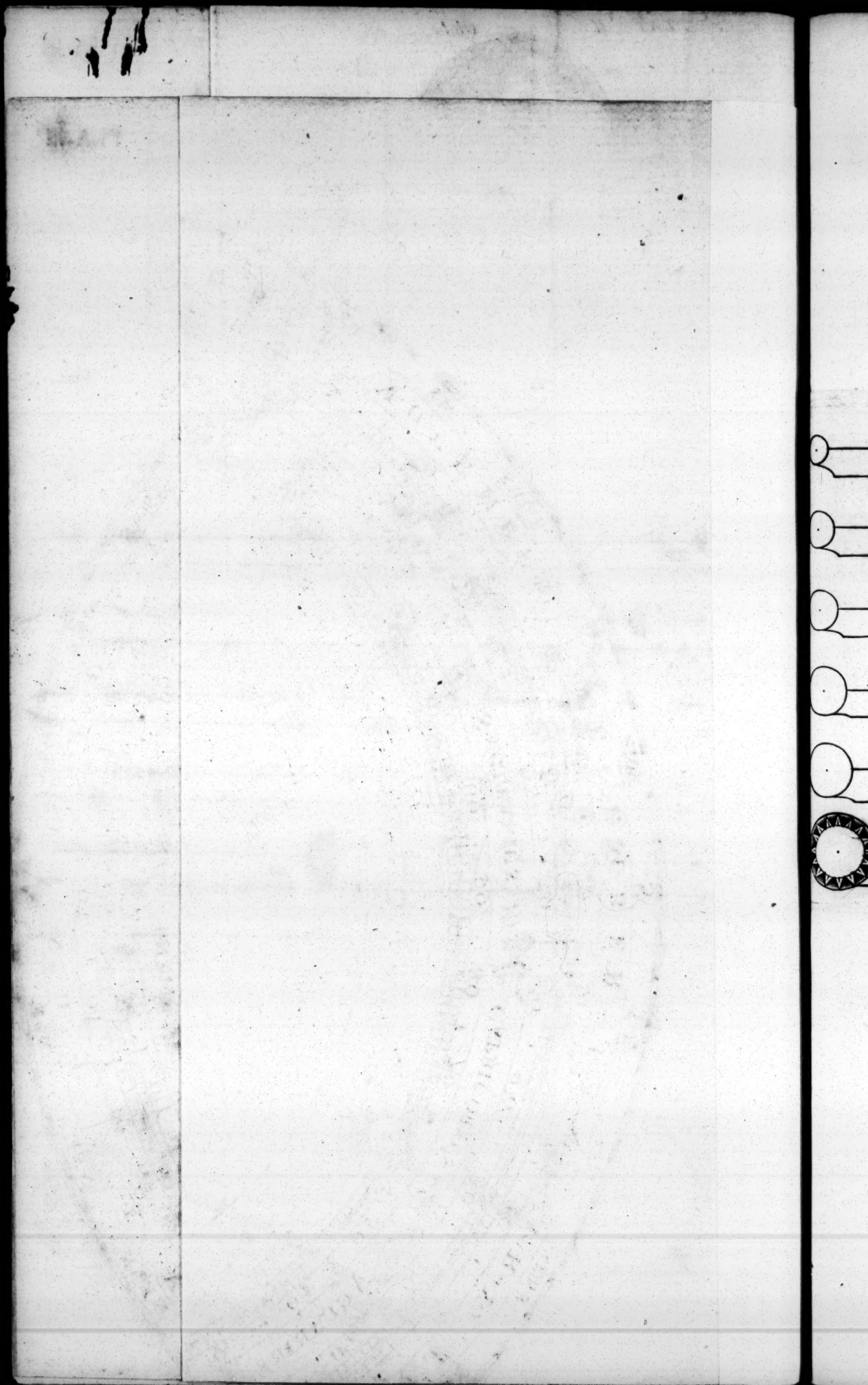


PLATE I.

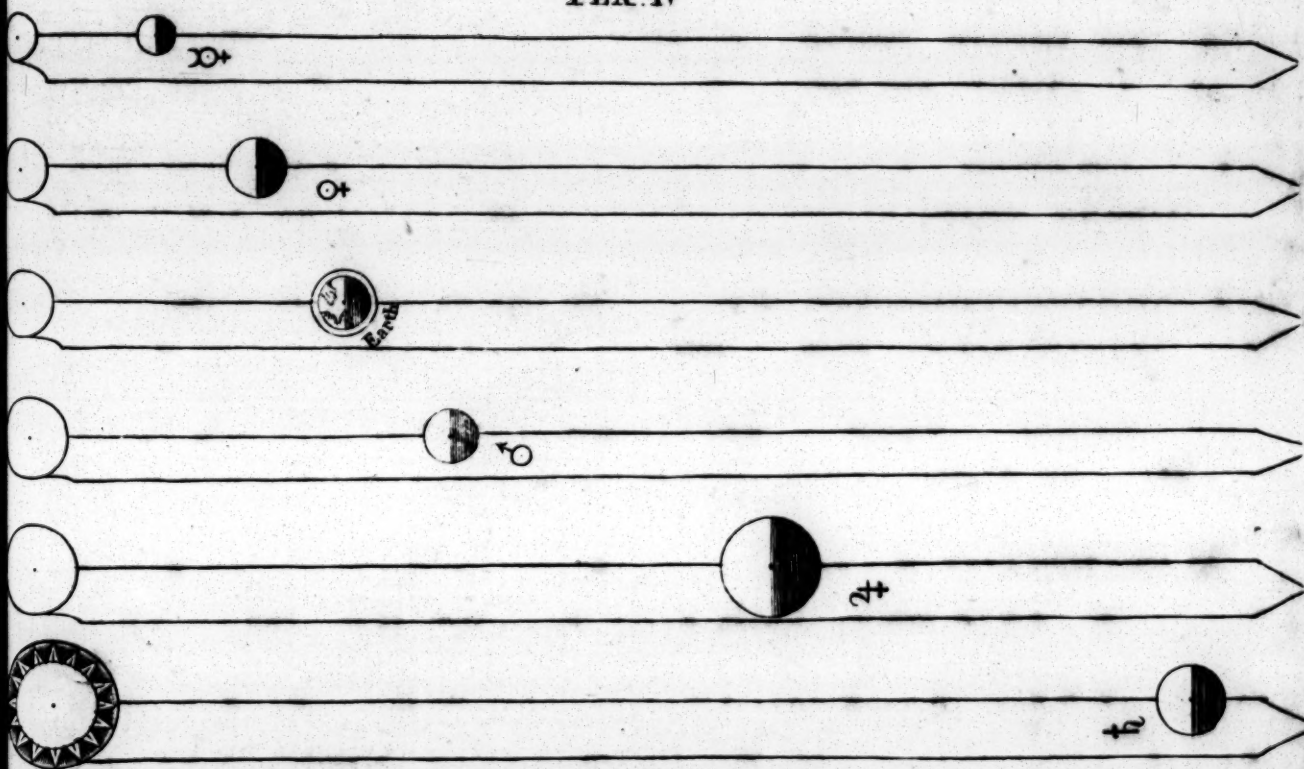


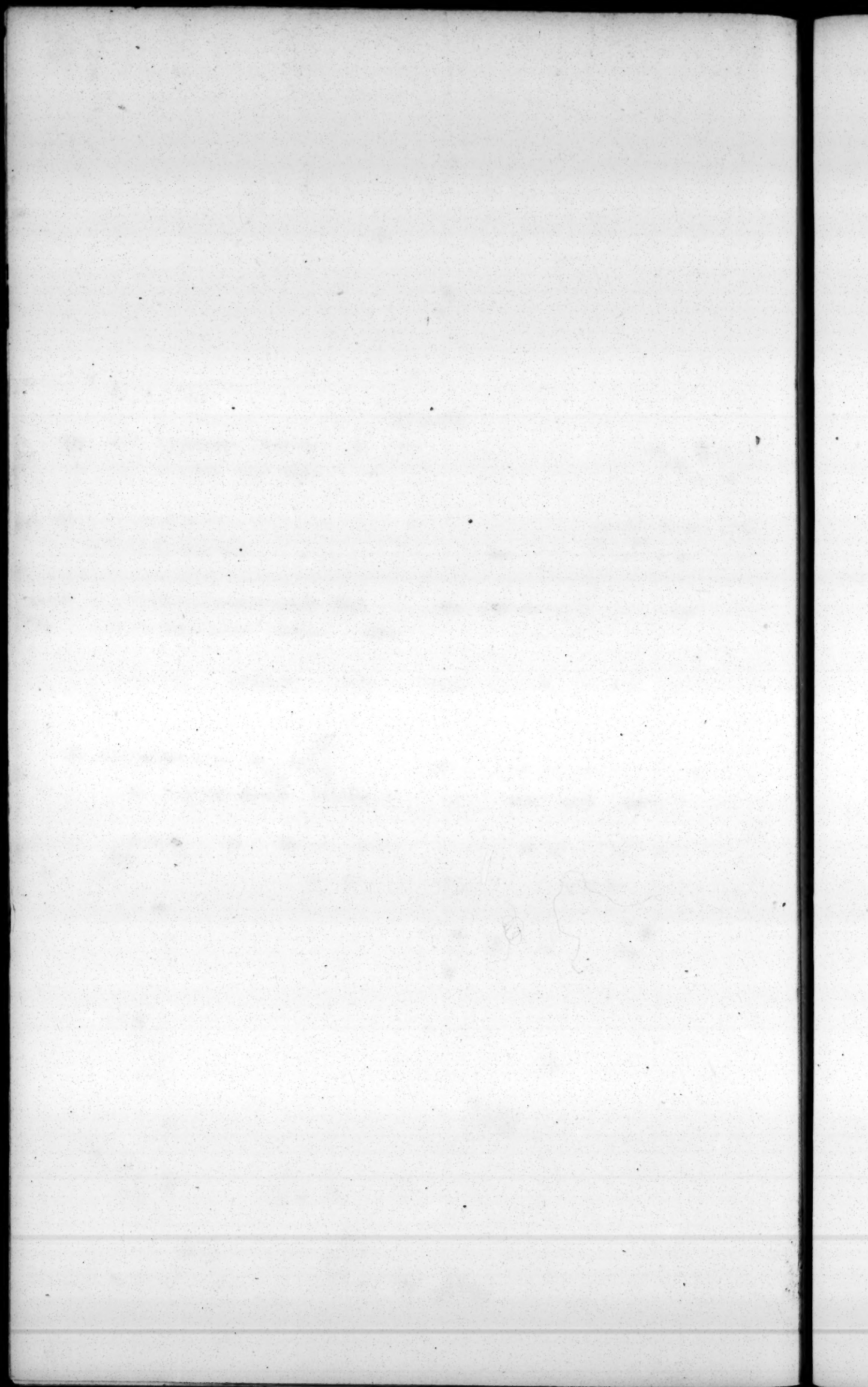
This PLATE is an Exact representation of the two Hour Circles as they are Engraved on the Surface of the New 12 Inch Globes, where the 24 Meridians pass thro the 24 hours from Pole to Pole. At the distance of 15 on the Equator they are Subdivided again into 2 & 4 hours of time, and by the Brass Index A moving very close to the Circle will admit of dividing it again into 8, a degree of Accuracy seldom made use of in any size Globes.





PLA. IV





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